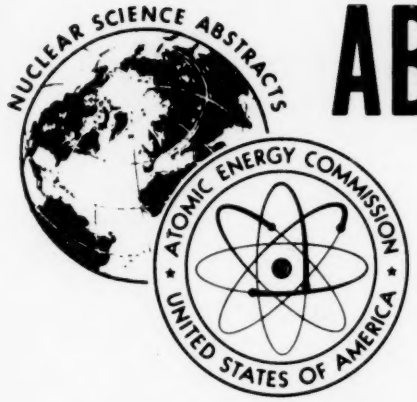
NUCLEAR SCIENCE ABSTRACTS



Volume 26 Number 8

Abstracts 17331-19919

April 30, 1972

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Volume 26, Number 8, April 30, 1972

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/Bib-254)

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation ccunting, 25:40 (IDO-12073, pp 28-36)

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Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

is indexed as:

CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Construction of a unique underground whole body counter, 25:372 (UCRL-72739)

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Volume 26, Number 8 April 30, 1972

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 17557, 18180, 18400, and 19722.

17331 (IS-2600, pp 25-123) CHEMISTRY DIVISION. (Ames Lab., Iowa). Dec 1971.

In Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1970-June 1971.

Research progress is reported in nuclear, structural and inorganic chemistry (diffraction and crystal structures, high-temperature chemistry, chemistry of the metallic elements, and theoretical chemistry) and radiation, isotope, and physical chemistry (analytical chemistry, radiochemistry, rare earth chemistry, reaction dynamics, surface chemistry, and spectroscopy). (D.H.M.)

17332 (ORNL-4749) ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1971. Lyon, W. S. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 86p. Dep. NTIS.

An abstract was prepared for each of the 10 sections. (M.C.G.)

For abstracts of individual sections see: 17333-17339 and 17390-17392.

17333 (ORNL-4749, pp 1-9) ANALYTICAL METHODOLOGY. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

Activities in environmental research, tobacco smoke analysis, cigarette smoke inhalation methodology, and in support of the Transuranium Research Laboratory are reported. (M.C.G.)

17334 (ORNL-4749, pp 10-18) REACTOR PROJECTS. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

Analytical developments for the Molten Salt Reactor Program are discussed. Analysis of natural gas from the Rulison well was performed. (M.C.G.)

17335 (ORNL-4749, pp 19-24) ANALYTICAL BIOCHEMISTRY. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

Progress is reported on Analyses in the Biological Macromolecular Separations Technology Project, the MAN Program, biochemical studies of the human variants group, and in characterization and purity of biochemicals. (M.C.G.)

17336 (ORNL-4749, pp 25-39) NUCLEAR AND RADIOCHEMISTRY. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

Trace element determinations in biological and environmental samples, effects of radiation on analytical methods, the nuclear safety support program, Cherenkov counting and phosphor screens, low-level γ spectrometry of returned lunar samples, cooperative isotopes and radiochemical studies programs, and new facilities and equipment are discussed. (M.C.G.)

17337 (ORNL-4749, pp 40-6) ANALYTICAL INSTRUMENTATION. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

Computer analytical systems and instrumentations research and development are reported. (M.C.G.)

17338 (ORNL-4749, pp 47-50) METHODS DEVELOPMENT AND EVALUATION LABORATORY. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

Developments are reported on characterization of LMFBR fuels, molten-salt reactor related analyses, and on special nonroutine analyses. (M.C.G.)

17339 (ORNL-4749, pp 60-3) PROCESS ANALYSES. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

17340 NUCLEAR METHODS IN ENVIRONMENTAL RESEARCH. Proceedings of American Nuclear Society Topical Meeting, Columbia, Missouri, August 23-24, 1971. Vogt, James R.; Parkinson, Thomas F.; Carter, Robert L. (eds.). Columbia, Mo.; University of Missouri (1971). 252p. $5.00. (CONF-710818).

Twenty-four papers on nuclear methods in environmental research were presented at the conference. A separate abstract was prepared for each of 20 papers. Four papers appeared previously in NSA. For abstracts of these see CONF-710818 in the Report No. Index. (L.C.L.)

For abstracts of individual papers see: 17341, 17356-17369, 17401, 17402, 17429, 17430, and 17696.

17341 TRACE ELEMENTS IN THE URBAN ATMOSPHERE. Gordon, G. E.; Zoller, W. H.; Gladney, E. S.; Jones, A. G. (Univ. of Maryland, College Park). pp 30-7 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

With the use of nuclear and nuclear-related analytical techniques, especially instrumental neutron activation analysis (INAA), high-quality data on trace-element concentrations in particulate material of urban atmospheres is being acquired. Some elements arising in large part from man-made sources can be readily identified by normalization of absolute atmospheric concentrations to abundances of the same elements in sedimentary rocks. Elemental concentration patterns of urban particulates can be resolved into contributions from various major source types with moderate success. Such resolutions could be greatly improved if more detailed information on characteristics of emissions from major sources were available. Other nuclear related methods that promise to be important tools for air pollution studies are electron spectroscopy for chemical analysis (ESCA) and nondispersive x-ray fluorescence following excitation by γ or x rays or by charged particles from nuclear accelerators. (auth)

17342 SOME IDEAS ON THE INFORMATION QUANTITY OF AN ANALYSIS, ESPECIALLY AN ELEMENTAL ANALYSIS.

Griepink, B.; Dijkstra, G. (State Univ., Utrecht). Z. Anal. Chem.; 257: No. 4, 269-72(1971). (In German).

An attempt to use the results of information theory in order to rationalize chemical elementary analysis is made. A method for calculation of the information of a one- or more-dimensional analysis using the results of the analysis is suggested. Errors are given for some elements, including iodine. (auth)

Activation and Nuclear Reaction Procedures

17343 (COO-2148-1) PROGRAM OF RADIOCHEMICAL STUDIES. Final Report. Gordus, Adon A. (Michigan Univ., Ann Arbor. Dept. of Chemistry). 30 Sep 1971. Contract AT-(11-1)-2148. 4p. Dep. NTIS.

17344 ACTIVATION ANALYSIS OF RARE EARTH ELEMENTS. Bereznai, T. (TUNGSRAM Research Labs., Budapest). J. Radioanal. Chem.; 9: No. 1, 81-100(Oct 1971).

A review of the activation analysis of rare earth elements is presented that includes cross section and detection limits, interferences due to reactor activation, nondestructive activation analysis, neutron generator activation analysis, photoactivation analysis, activation by isotopic neutron sources, radiochemical methods, and applications. (181 references) (D.H.M.)

17345 ACTIVATION ANALYSIS OF HIGH-PURITY SILICON. III. MULTI-ELEMENT ACTIVATION ANALYSIS: APPLICATION OF THE TRIPLE COMPARATOR METHOD. De Corte, F.; Speecke, A.; Hoste, J. (Univ., Ghent). J. Radioanal. Chem.; 9: No. 1, 9-17(Oct 1971).

The triple comparator method is used for the analysis of impurities of high-purity silicon by neutron activation. The ratios of the specific photopeak activities of the isotopes investigated to the specific photopeak activities of the gold, indium, and cobalt comparators were determined. The triple comparator method avoids some tedious problems in the multi-element activation analysis and it is very well suited for the determination of "non-expected" elements. (auth)

17346 SUBSTOICHIOMETRIC DETERMINATION OF RHENIUM IN COPPER ORES AND MOLYBDENUM CONCENTRATES BY NEUTRON ACTIVATION ANALYSIS. Doctor, Z. K.; Haldar, B. C. (Inst. of Science, Bombay). J. Radioanal. Chem.; 9: No. 1, 19-25(Oct 1971).

A simple and rapid substoichiometric method is described for the estimation of rhenium in copper ores and molybdenum concentrates by neutron activation analysis. 2 μg of Re can be determined with an accuracy of 4%. The variation of the mean at 95% confidence limit does not exceed 2%. The time required for processing three samples is less than 60 min. (auth)

17347 INVESTIGATION OF THE POSSIBILITY OF USING THE GAMMA-ACTIVATION METHOD TO DETERMINE THE COPPER CONTENT IN COPPER ORES. Nikitin, V. N.; Kurenko, E. Ya.; Viryukov, V. F.; (and others). Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 7, 156-63(1969). (In Russian).

The possibility is demonstrated of determining the copper content in copper ores by a simplified version of the gamma-activation method. This version is based on irradiation of the sample by the braking gamma-radiation of a betatron at such values of minimum radiation energy that copper is activated just sufficiently for analysis, while admixed elements (primarily iron) are activated to an insignificant degree. It was determined experimentally that the optimum maximum energy needed for the cupriferous sandstones of the Udokan deposit and the chalcopyrite ores of the Kafan deposit is 15 MeV. Results of testing the proposed simplified version on 20 samples of copper ores and artificial mixtures weighing up to 400 g showed a directly proportional relationship between induced activity of the sample and its copper content. (Geophys. Abstr.)

17348 ISOTOPE CATALOGUE FOR INSTRUMENTAL ACTIVATION ANALYSIS. III. Pagden, I. M. H.; Pearson, G. J.; Bewers, J. M. (Bedford Inst., Dartmouth, N. S.). J. Radioanal. Chem.; 9: No. 1, 101-89(Oct 1971).

The energies of γ-transitions of the isotopes are listed in the order of increasing energy. (auth)

17349 APPLICATION OF MONITORS IN NEUTRON ACTIVATION ANALYSIS. Dubinskaya, N. A.; Pelekis, L. L. (Inst. of Physics, Riga). J. Radioanal. Chem.; 9: No. 1, 61-72(Oct 1971).

The character and values of corrections are discussed which are required in the application of monitors (in particular, copper monitors) for the activation analysis of copper, zinc, and manganese in biological samples. (auth)

17350 APPLICATION OF 8-MERCAPTOQUINOLINE (THIOOXINE) FOR THE SEPARATION OF MICROAMOUNTS OF ELEMENTS. Veveris, O. E.; Bankovskii, Yu. A.; Pelekis, L. L.; Aynbinder, N. G.; Shekhtmeyster, L. A. (Inst. of Physics, Riga). J. Radioanal. Chem.; 9: No. 1, 47-53(Oct 1971).

The separation of elements by means of thiooxine is reviewed. The extraction ranges of the thiooxinates of manganese, iron, cobalt, copper, zinc, and mercury, for metal contents of 10^{-7} to 10^{-9} g, were determined using the radioactive tracer method. Solubility values in chloroform and distribution coefficients in the system chloroform–water were determined for mercury, zinc, and iron thiooxinates. Polytetrafluoroethylene powder was used to eliminate chloroform traces from the aqueous phase. (auth)

17351 PROBLEMS IN APPLYING SECONDARY REACTIONS TO THE ACTIVATION ANALYSIS OF SEMICONDUCTOR SURFACE LAYERS. Rausch, H.; Salamon, A.; Szabo, E. (Central Research Inst. for Physics, Budapest). J. Radioanal. Chem.; 9: No. 1, 39-46(Oct 1971).

Investigations were made concerning the determination of special contaminants (e.g., oxygen and boron) in the surface layers or epitaxially grown layers of semiconductor crystals. These contaminants are insensitive to the conventional (n,γ) analysis and for their activation charged particles (e.g., t, α) from nuclear reactions induced by the capture of reactor neutrons are used. The specific particle yield from such reactions, e.g., $^{6}Li(n,t)\alpha$, was studied. The optimum conditions for the producing of activating layers (containing Li) and their optimum contact with the sample under investigation are discussed. Considering the so-called activation depth, a method was developed for the appropriate removal of the activated layer and the elements to be determined are subsequently separated from the semiconductor matrix by a fast chemical procedure. The combined activation cross sections measured on standard samples are given for different compositions and species of activating layers. (auth)

17352 DETERMINATION OF TRACE IMPURITIES IN TIN BY NEUTRON ACTIVATION ANALYSIS. II. DETERMINATION OF INDIUM AND MANGANESE. Maenhaut, W.; Adams, F.; Hoste, J. (Univ., Ghent). J. Radioanal. Chem.; 9: No. 1, 27-38(Oct 1971).

Two methods are described to determine indium and manganese in high-purity tin. In the first method indium and manganese are separated from the tin and antimony matrix activities on Dowex 1X8 anion exchanger. Tin and antimony are adsorbed in 10M HF while indium and manganese are eluted. In the second method the incident γ-ray intensity due to the tin matrix is reduced by placing a lead absorber between the sample and the detector. The reproducibility and the sensitivity of both methods are of the order of 10 ppB for manganese and of 1 ppB for indium for 1 g samples and a neutron flux of 10^{11} n · cm^{-2} · sec^{-1}. (auth)

17353 PRODUCTION OF NITRIC ACID SOLUTIONS OF SILVER, PLATINUM, AND GOLD USING ALTERNATING CURRENT. Artyukhin, P. I.; Startseva, E. A.; Sil'vanovich, Yu. A.; (and others). Sov. Radiochem. (Engl. Transl.); 13: No. 4, 681 (Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 660(Jul-Aug 1971).

For neutron activation determination of trace impurities in silver, an electrochemical method of dissolution under the action of alternating current is suggested. The completeness of the passage of platinum and gold into solution was verified by activation analysis of standard samples. (M.C.G.)

17354 CHOICE OF REAGENT FOR PHOTOMETRIC ANALYSIS WITH A NEW METHOD OF SENSITIVITY EVALUATION. Patrovsky, Venceslav. Chem. Listy; 65: No. 11, 1121-36 (Nov 1971). (In Czech).

Photometric methods having suitable analytical properties are discussed. The correct absorption maxima of the corresponding reaction products, as well as the corresponding sensitivity of determination expressed in molar absorption coefficient and the absorption index (AI) proposed are presented. All these data are tabulated. (auth)

17355 DETERMINATION OF WHOLE-BODY CALCIUM BY NEUTRON ACTIVATION ANALYSIS IN VIVO. Fremlin, J. H. (Univ. of Birmingham, Eng.). Semin. Nucl. Med.; 2: No. 1, 86-93(Jan 1972).

In vivo neutron activation analysis has become a practical means of determining total body calcium content in living man. The procedure can be used for sequential studies in individuals as well as

for study of trends in disease states. The methodology currently in use and some typical results in recent studies are described. The radiation dose received by the patient is estimated to be less than 2 rem. The procedure permits estimation of total body calcium with an absolute error of less than 5%. The data are not obtainable by any other procedure that can be applied to living man. (auth)

17356 NONDESTRUCTIVE MULTI-ELEMENT NEUTRON ACTIVATION ANALYSIS OF AIR POLLUTION PARTICULATES. Dams, Richard; Rahn, Kenneth A.; Nifong, Gordon D.; Robbins, John A.; Winchester, John W. (Univ. of Michigan, Ann Arbor). Contract AT(11-1)-1705. pp 8-15 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

A nondestructive and computer-assisted neutron activation analytical procedure was developed for the determination of up to 33 elements in air pollution particulates. The procedure was tested in pilot studies of samples taken in and near the urban-industrial area of Northwest Indiana and Chicago. Following a 5-minute neutron irradiation, the sample is counted after (a) 3-minute and (b) 15-minute decay periods giving spectra suitable for determination of (a) Ca, Ti, V, Cu, Al, S and (b) Na, Mg, Mn, In, Cl, Br, I. Following a 2 to 5 hour neutron irradiation the sample is counted after (c) 20 to 30 hour and (d) 20 to 30-day decay periods suitable for determination of (c) K, La, Sm, Eu, Cu, Zn, W, Au, Ga, As, Sb, Br, and (d) Sc, Ce, Th, Cr, Fe, Co, Ni, Ag, Zn, Hg, Sb, and Se. In one test a 36-hour time series of 90-minute samples indicates that both meteorological and time-dependent source processes may influence concentrations of the elements determined. In another study, analyses of 25 samples, which were collected by filters simultaneously over a network including both urban and rural locations, indicated that some, but not all, elements have principal sources lying within the urban and industrial region. In the same region size fractions of particles were collected by cascade impactors fitted with polyethylene impaction surfaces. Systematic differences were observed over the radius range 0.1 to 10 microns where refractory metals, such as Fe, Al, and the rare earths, were found on distinctly larger particles than elements such as Zn, In, As, and Sb where vapor condensation in some high-temperature industrial sources is expected. (auth)

17357 OIL-SLICK IDENTIFICATION CERTAINTIES WITH THE METHOD OF NEUTRON ACTIVATION ANALYSIS. Lukens, H. R.; Bryan, D. E.; Hiatt, M. A. (Gulf Radiation Tech., San Diego, Calif.). pp 62-71 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

Neutron activation analysis has been shown to provide a means of identifying oil slick sources by comparison of the trace element patterns (TEPs) of slick and source samples. This work has involved the definition of concentration stability of the various trace elements toward environmental influences, measurement of the TEPs in a random sampling of over 250 oil slicks and candidate slick sources on U. S. coastal waterways, examination of known matched pairs for both laboratory sources and ocean slicks and development of an objective method of comparing the TEPs of sample pairs. Measured element concentrations are converted to normalized integer point values. Differences in point values for the various elements observed in the two samples are summed, and a calibrated constant value is added for each element that is obtained in one sample but not in the other. The sum is called a difference score (DS). Distribution functions for matched-pair DS values and unmatched-pair DS values were obtained. The overlap of these functions is very small, and in the vast majority of cases the DS value clearly indicates whether the two samples have a common source or different sources. (auth)

17358 CALIFORNIUM BASED SYSTEM FOR THE AUTOMATED DETECTION OF HEAVY METALS IN INLAND WATERS. John, Joseph (Gulf Radiation Tech., San Diego, Calif.). pp 72-85 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

An automated and computer-controlled system was designed for the detection of heavy metals in inland waters. It employs neutron activation analysis using 5 mg of ^{252}Cf. Only instrumental analysis is performed and the method is fast. Although this method is not suitable for all elements, it provides sufficient sensitivity for many elements to become a practical instrument. Feasibility of such an instrument is discussed using the results of recent laboratory experiments. To overcome any deterioration in detection limits due to interference, a reverse osmosis pre-concentration unit is planned to enhance the sensitivity. The properties of cellulose acetate membranes for the rejection of heavy metals are discussed. (auth)

17359 MODE OF OCCURRENCE OF TRACE ELEMENTS IN PETROLEUM AND RELATIONSHIP TO OIL-SPILL IDENTIFICATION METHODS. Filby, R. H.; Shah, K. R. (Washington State Univ., Pullman). pp 86-96 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

In this study thermal neutron activation analysis was used to measure Ni, V, Co, Hg, Fe, Zn, Cr, Cu, Mn, As, Sb, Se, Sc, Na, and Ca in crude oil. The TRIGA III-fueled reactor at Washington State University with a maximum thermal neutron flux of 1.2×10^{13} neutrons/cm^2/sec was used and the measuring system was a 65-cm^3 Ge(Li) detector and a ND-2200 4096-channel analyzer. Nuclear reactions used were (n,γ) except for the $^{58}Ni(n,p)^{58}Co$ reaction. A computer program (FOURIER) was used for spectrum analysis and data reduction. The method is nondestructive and samples as small as 50 mg can be analyzed. Analyses of 6 oils showed large variations in trace element contents even within a given oil well. All elements were shown to occur in oil-soluble form but Na, As, and Sb were found to occur partly as water-soluble compounds. All elements were most concentrated in the asphaltenes of one crude oil studied. The ratios of asphaltene/crude concentrations varied from 3.4 (As) to 23.6 (Sb). Asphaltenes of a California oil were separated by gel-permeation-chromatography into 300 to 1,000, 1,000 to 4,000, 4,000 to 8,000, and 8,000 to 22,000 molecular-weight fractions. The 8,000 to 22,000 fraction was found only in the asphaltenes, except for Ni and Sb. Nickel was highest in the low-molecular-weight fraction of the asphaltenes due to the presence of Ni-porphyrin. Antimony showed decreasing values with increasing molecular weight. Nickel was found to be present as both Ni-porphyrins and nonporphyrin Ni. In the low-molecular-weight fractions, the Ni was entirely Ni porphyrin. Porphyrins of elements other than Ni and V were not found. Arsenic and Sb occur partly in the oil as low-molecular-weight compounds, possibly alkyl or aryl arsines or stibines. The implications of the finds for tagging procedures are discussed. (auth)

17360 ACTIVATION ANALYSIS AS USED IN A STUDY OF SEDIMENTATION. Pedersen, Knud B.; Gileadi, Aviva (Univ. of Puerto Rico, Mayaguez. Puerto Rico Nuclear Center, Mayaguez). pp 104-10 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

Feasibility of using a naturally occurring labeling element for tracing sediment motion in a river and a river-ocean interface was studied. Neutron activation analysis was employed on river and ocean sediment samples and aluminum concentration in the samples was found to be a discernible function of various parameters. Results obtained so far have been consistent and informative. They show that, as expected, the amount of sediment carried by the river increases with increasing discharge rate, varying as a smooth function. Less expectedly it was also found that for surface samples the aluminum concentration increases as a smooth function of the discharge rate, asymptotic to a maximum value. Data taken from the river mouth and from several kilometers upstream are coincident. Samples taken near the bottom do not show the same trend, although conclusions cannot be made from the amount of data available. For the bottom samples taken at the river mouth it must be assumed that saltwater incursion is an additional factor. The results indicate that the bar forming in front of the river during the season of low discharge consists mainly of material deposited by shore currents, not by the river itself. (auth)

17361 OIL SLICK IDENTIFICATION UTILIZING CHARGED PARTICLE ACTIVATION TECHNIQUES. Mandler, J. W.; Reed, J. H.; Moler, R. B. (IIT Research Inst., Chicago). pp 111-16 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

A series of studies is underway to investigate the possibility of identifying oils and oil slicks by analysis of trace elements via charged particle activation (CPA) techniques. In the initial studies, four oil slick samples that were suspected of originating

from the same spill and four crude oils obtained from the U. S. Bureau of Mines were analyzed. A sample of each oil was ashed via a dry ashing process and then bombarded with protons of energy 1000 to 1800 keV. The γ rays produced by the proton-induced reactions were measured using a 40-cm^3 Ge(Li) detector. Analysis of the γ spectra from the four oil slick samples indicated that they had similar structure. In particular, all four samples contained the same relative concentrations of vanadium and nickel. One sample, however, contained more sodium than the others. The crude oil samples all exhibited different γ spectra and different concentrations of V, Ni, Al, S, and Na. The four crude oils can easily be distinguished from each other by determining their relative concentrations of these elements. (auth)

17362 DETERMINATION OF LEAD IN ENVIRONMENTAL SAMPLES BY PHOTON ACTIVATION ANALYSIS. Lutz, George J. (National Bureau of Standards, Washington, D. C.). pp 144-9 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

Photon activation analysis was applied to the determination of Pb in environmental samples. Electrons are accelerated to a suitable energy (20 to 45 MeV) with a linear accelerator and allowed to strike a tungsten target. High-energy photons, called bremsstrahlung, are produced from the interaction of the electrons with the coulomb field of the tungsten atoms. Part of this bremsstrahlung is of sufficiently high energy to induce the reaction $^{204}Pb(\gamma,n)^{203}Pb$. ^{203}Pb has a half-life of 52 hours and decays with the emission of a 279-keV γ ray. After irradiation, the sample is either counted nondestructively with a Ge(Li) detector or the Pb is separated after dissolution of the sample by extraction into methyl isopropyl ketone or by more rigorous methods and then counted with a Ge(Li) or NaI(Tl) detector. Precision and accuracy were determined to be adequate by analyzing some soil and biological samples which had been assayed for Pb by other methods. Interfering photonuclear reactions do not occur below 45 MeV. The limit of nondestructive determination with a Ge(Li) detector is about 0.5 ppM. With a rigorous separation, about 10 nanograms can be determined. (auth)

17363 MULTI-ELEMENT SURVEYS OF BIOENVIRONMENTAL SAMPLES USING NEUTRON ACTIVATION ANALYSIS. McKown, D.; Kay, M.; Gray, D.; (and others) (Univ. of Missouri, Columbia). pp 150-7 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

Neutron activation analysis was used for a quantitative multi-element survey of a variety of bioenvironmental samples. Techniques and data are given for multi-element surveys of wood, bone, airborne particulates, water, soil, and acid extracts of soils. All analyses were made using a 45-cm^3 Ge(Li) detector coupled to an 8192-channel Packard pulse height analyzer. Data reduction is done with a computer program, BARFF. (J.G.B.)

17364 ENVIRONMENTAL TRACE ELEMENT SURVEY AT A HEAVY METALS REFINING SITE. O'Toole, J. J.; Clark, R. G.; Malaby, K. L.; Trauger, D. L. (Ames Lab., Iowa). pp 172-85 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

A survey of trace elements was conducted in the vicinity of gold mining and refining operations at Yellowknife, Northwest Territories. Instrumental neutron activation analysis techniques were used for multi-element analysis of samples of soil, water, snow, vegetation, and human hair collected near the site. The elements studied were related to the refinery effluent. Concentrations of As, Sb, Co, Hg, Cr, La, Eu, and Au were determined. Arsenic, Sb, and Hg levels were very high in all environmental samples examined. Cobalt was excessively high in most samples. Hair analyses showed As and Hg mean levels higher than normal levels. Results were correlated with sample location and physical properties. Observations on biological concentration factors of certain elements also were discussed. (auth)

17365 TRACE MERCURY DETERMINATIONS IN A VARIETY OF FOODS. Jervis, R. E.; Tiefenbach, B. (Univ. of Toronto). pp 188-96 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

A rough survey of Hg contamination in a variety of foods was completed. Neutron activation determinations of Hg concentrations in the range from 1 ppB of 5 ppM were carried out by a combination of radiochemical and scintillation γ spectrometric techniques. An estimate of the average daily Hg consumption from the diet based on the Hg residues obtained in this study was about 50 micrograms per day. Monitoring of the body burden of Hg by analysis of head hair is reported. A range of contents from 1 ppM for the normal population to more than 1000 ppM for persons exhibiting gross symptoms of severe Hg toxicity, has been found. These results suggest Hg concentrations in hair can provide a useful index of exposure for monitoring the general public or persons who may have ingested unusual quantities of Hg. (auth)

17366 DETERMINATION OF MERCURY IN BIOLOGICAL SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Bate, L. C. (Oak Ridge National Lab., Tenn.). pp 197-200 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

Although neutron activation analysis (NAA) provides probably the highest sensitivity for analytical determination of Hg, care must be exercised in applying the technique, since each step in the procedure has its particular pitfall. The activation procedure quite naturally divides itself into three distinct parts: sample preparation and irradiation, post-irradiation distribution and chemical separation, and counting. Only the latter is relatively straightforward; however, attempts to eliminate the second step (separation) and use only the third for identification of Hg at the sub-microgram level generally strain the technique of nondestructive analysis beyond its limit. The first two steps in the procedure were investigated using a number of biological-type samples. It was concluded that irradiation for more than a few minutes should be made in quartz, not plastic. Dissolution technique using a $H_2SO_4-HNO_3-NH_4VO_3$ mixture can completely dissolve most samples in 15 to 20 minutes. Chemical separation of the Hg as the sulfide will give Hg recoveries greater than 90%. Results obtained when Hg samples and standards were irradiated in polyethylene containers are given. Using the techniques described above, comparisons were made for determination of Hg by NAA and flameless atomic absorption in fish, wheat, and flour at levels ranging from 2 micrograms to 5 nanograms. These data indicate NAA to be the more sensitive and reliable technique. (auth)

17367 SOME NEW ASPECTS OF THE NEUTRON ACTIVATION ANALYSIS DETERMINATION OF MERCURY IN SEAFOODS. Guinn, V. P.; Kishore, R. (Univ. of California, Irvine). pp 201-4 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbi, Mo.

The feasibility of efficiently using the purely instrumental form of neutron activation analysis for Hg determinations in seafood is explored. Methods are suggested by which the precision and accuracy of this technique can be improved. In the case of seafood the limit of detection, under the conditions employed, is about 0.02 ppM Hg. (auth)

17368 ENVIRONMENTAL STUDIES OF MERCURY AND OTHER ELEMENTS IN COAL AND LAKE SEDIMENTS AS DETERMINED BY NEUTRON ACTIVATION ANALYSIS. Kennedy, E. Joyce; Ruch, R. R.; Gluskoter, H. J.; Shimp, N. F. (Illinois State Geological Survey, Urbana). pp 205-15 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

Radiochemical separation techniques for determining Hg in coal and fresh water sediments were developed and applied. The procedures involve hot-tube combustion or volatilization followed by chemical entrapment. Coals from Illinois and elsewhere were analyzed for Hg. The range for coals currently being mined in Illinois is 0.04 to 0.49 ppM, with an average of 0.18 ppM. Coals from most other states fall within this range. Washability studies indicate that the mercury is primarily, but not totally, associated with the pyrite-rich fractions. Arsenic, Br, Se, Sb, and other elements in the whole coal are now being investigated. Some 132 samples of southern Lake Michigan unconsolidated bottom sediments from 31 sampling stations were assayed for Hg. A base level of 0.03 to 0.06 ppM was found in the deeper portions of the cores, whereas up to 0.38 ppM was detected in the top sediment intervals in various parts of the lake. Mercury concentrations are highest in fine-grained lake bottom surficial sediments off major river mouths and correlate well with the organic carbon and total sulfur concentrations of the samples. These results are consistent with data for other elements (As, Br, Cr, Pb, and

Zn) determined on the same samples by neutron activation analysis and other techniques. (auth)

17369 CRITICAL LOOK AT THE CURRENT PROBLEMS IN MERCURY ANALYSES. McLain, M. E. Jr.; Leddicotte, G. W. (Georgia Inst. of Tech., Atlanta). pp 216-25 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

In a study of several methods, including atomic absorption spectroscopy and neutron activation, that could be used to determine trace mercury in fish and related materials, a deliberate effort was made to account for all of the critical criteria that must be met to provide accurate and precise analytical data. Findings of this study are reported. A practical and routine method for the determination of mercury in concentrations as small as 10^{-10} gram is emphasized. (J.G.B.)

17370 QUANTITATIVE ANALYSIS OF BORON IN SOLIDS BY AUTORADIOGRAPHY. Garnish, J. D.; Hughes, J. D. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Mater. Sci.; 7: No. 1, 7-13(Jan 1972).

A nondestructive method of quantitative analysis for B is described. The method, which depends on the use of a plastic film to record tracks from the $^{10}B(n,\alpha)^{7}Li$ reaction, is in general applicable to any solid material but is here described in detail for the analysis of ferrous alloys. Boron contents from 1 ppm to 10% may be determined, and the technique may be applied also to microanalysis of individual features such as precipitates and grain boundaries in the metal structure. (auth)

17371 ACTIVATION ANALYSIS OF CALCIUM IN BOREHOLES. Koshelev, I. P.; Belenko, R. D.; Shepelev, G. I.; Shishakin, O. V.; Krasnoperov, V. A. Vop. Razved. Geofiz.; No. 11, 112-16(1969). (In Russian).

Neutron activation of Ca in rocks forms ^{49}Ca through a (n,γ) reaction with the small amount of ^{48}Ca present, the only interference arising is the similar formation of ^{56}Mn and ^{24}Na through the use of a Po-Be source. Interpretation of the results from activation analysis in well logging is offered, and a description of the neutron source and measuring equipment is given. (K.S.W.)

17372 DETERMINATION OF RARE EARTH ELEMENTS IN HOT SPRINGS BY ACTIVATION ANALYSIS, USING Ge(Li) DETECTOR, AND GEOCHEMICAL STUDIES ON THOSE ELEMENTS. Oda, Toshiyuki (Kyushu Univ., Beppu, Japan). Onsen Kagaku; 21: No. 1, 17-25(Mar 1970). (In Japanese).

The lanthanum, samarium, europium, gadolinium, dysprosium, ytterbium, and scandium contents in Tatsumakijigoku and Umijigoku Hot Springs were determined by activation analysis, a lithium-drifted germanium high-resolution semiconductor detector being used. Samples of spring water, deposits from thermal water, core and pyroxene andesite were used for an analysis. The neutron irradiation was carried out by using a JRR-2 Reactor (thermal neutron flux $8 \times 10^{13} n/cm^2$ sec) for twenty minutes. Rare earth elements in hot spring waters were studied geochemically. The content of rare earth elements in acid hot spring waters was found to be higher than in neutral or alkaline spring waters. The relative abundance of the rare earth elements in the core sample almost coincides with the Clarke Numbers of the corresponding elements. On the other hand, the relative abundances of those elements in the hot spring waters and the deposits coincided with those in a fresh rock sample of pyroxene andesite. (auth) (Japan)

17373 DETERMINATION OF RARE EARTH ELEMENTS IN HOT SPRING WATERS BY ACTIVATION METHOD IN COMBINATION WITH ION EXCHANGE SEPARATION METHOD. Oda, Toshiyuki (Kyushu Univ., Beppu, Japan). Onsen Kagaku; 21: No. 1, 7-16(Mar 1970). (In Japanese).

An activation method, in combination with an ion exchange method, was studied for a determination of the rare earth elements in hot spring waters. The content of lanthanum, samarium, europium, and scandium was determined in the water samples from Yunotsu Hot Springs and Ikeda Mineral Springs. The rare earth elements contained in a 10-liter water sample were coprecipitated with calcium oxalate. After being ignited carefully, the precipitates were irradiated with neutrons by using the KUR (neutron flux $2 \times 10^{13} n/cm^2$ sec) for 5 hr. Then the rare earth elements were separated radiochemically by an ion exchange method, using 0.5 M ammonium citrate solution of pH 3.5 as an eluant. Radioactivity was measured by using the 512-channel PHA. The amounts of the rare earth elements in the water samples from Yunotsu and Ikeda were 0.08 to 0.13 μ g/l La, 0.02 to 0.07 μ g/l Sm, 0.005 to 0.008 μ g/l Eu, and 0.4 to 0.8 μ g/l Sc. (auth) (Japan)

17374 DETERMINATION OF MERCURY IN SOME AMERICAN COALS. O'Gorman, J. V.; Suhr, N. H.; Walker, P. L. Jr. (Pennsylvania State Univ., University Park). Appl. Spectrosc.; 26: No. 1, 44-8(Jan-Feb 1972).

A study was made of the use of three different analytical methods for the determination of mercury in coals: double gold amalgamation and flameless atomic absorption, neutron activation, and combustion-solution with flameless atomic absorption. Ten coal samples of varying rank were analyzed and comparisons are drawn between the various analytical procedures. The distribution of mercury in coals is discussed briefly. (auth)

17375 DETECTION OF SELECTED AIR POLLUTANTS USING A LABORATORY NEUTRON GENERATOR. Persiani, Carmine (GTE Labs. Inc., Bayside, N. Y.). Amer. Ind. Hyg. Ass. J.; 32: No. 9, 573-8(Sep 1971).

A method for the determination of selected airborne particulates is described. Neutron activation analysis using a Cockcroft-Walton accelerator is employed. The method is direct, nondestructive, and avoids sample dissolution, ashing, and separation procedures. The results by neutron activation were compared with those obtained by the emission spectrographic method. (auth)

17376 RAPID DETECTION OF FIREARM DISCHARGE RESIDUES BY ATOMIC ABSORPTION AND NEUTRON ACTIVATION ANALYSIS. Krishnan, S. S.; Gillespie, K. A.; nderson, E. J. (Centre of Forensic Sciences, Toronto). J. Forensic Sci.; 16: No. 2, 144-51(Apr 1971).

A rapid method of detection of firearm discharge residues on the hands of a person who has fired a gun is described. The sample is taken by washing the hands with 1.0 molar nitric acid, with detection of lead by atomic absorption spectrophotometry and antimony by neutron activation analysis in the washings. The method is instrumental and no chemical separations are necessary. The technique can be used by relatively inexperienced technical persons. When necessary, dozens of hands can be tested in a single day. (auth)

17377 RECENT RESULTS IN THE DETERMINATION OF OXYGEN CONTENT BY METHODS OF MODERN PHYSICS. Berenyi, Denes (MTA Atommag Kutato Intezete, Debrecen, Hungary). Magy. Kem. Lapja; 26: No. 12, 635-9(Dec 1971). (In Hungarian).

Results in the determination of oxygen carried out by the methods of modern physics are surveyed and data from different types of activation analysis (fast neutron, charged particle, gamma) are given in tables. (55 references) (auth)

17378 APPLICATION OF A CHERENKOV DETECTOR IN CHARGED PARTICLE ACTIVATION ANALYSIS. Thomas, J.-P.; Schweikert, E. A. (Texas A and M Univ., College Station). Radiochem. Radioanal. Lett.; 9: No. 3, 155-68(22 Feb 1972).

Charged particle activation analysis yields a number of nuclides emitting high-energy positrons, for which selective counting with a Cherenkov detector appears feasible. The principle, the evaluation of a converter, and the features and limitations of this counting method are discussed and illustrated with experimental data. (auth)

17379 ON-STREAM 14 MeV NEUTRON ACTIVATION ANALYSIS USING ULTRA-SHORT HALF-LIFE PRODUCTS. Hayward, C. C.; Oldham, G.; Ware, A. R. (Loughborough Univ. of Tech., Eng.). Radiochem. Radioanal. Lett.; 9: No. 3, 179-87(22 Feb 1972).

Fast-neutron activation analysis, in a nonaqueous flowing system, was applied to the determination of elements producing radionuclides with half-lives in the range 0.80 to 60 sec. Analysis was shown to be both feasible and reproducible. The optimum flow rate for the production and detection of each product isotope and the detection limits obtained for each element are described. Optimum flow rates may be readily predicted after the initial calibration of a given flowing system. (auth)

17380 N-BENZOYL-N-PHENYLHYDROXYLAMINE AS A SUBSTOICHIOMETRIC EXTRACTANT IN ACTIVATION ANALYSIS. IV. DETERMINATION OF ANTIMONY. Tejam, B. M.; Haldar, B. C. (Inst. of Science, Bombay). Radiochem. Radioanal. Lett.; 9: No. 3, 189-97(22 Feb 1972).

A method was developed for the substoichiometric neutron activation analysis of traces of antimony, based on the extraction of Sb(III) with N-benzoyl-N-phenylhydroxylamine in chloroform. The antimony content of biological materials, alloys, etc., was determined by the proposed method. (auth)

17381 N-BENZOYL-N-PHENYLHYDROXYLAMINE AS A SUBSTOICHIOMETRIC EXTRACTANT IN ACTIVATION ANALYSIS. V. DETERMINATION OF LANTHANUM IN ROCKS. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). Radiochem. Radioanal. Lett.; 9: No. 3, 205-12(22 Feb 1972).

N-Benzoyl-N-phenylhydroxylamine was used for the substoichiometric extraction of trace amounts of lanthanum in rocks after thermal neutron activation. The La–BPHA complex (1:3) is extracted at pH 6 with chloroform. Two samples and one standard can be analyzed in less than an hour. The method was used for the determination of lanthanum in five standard rocks and one meteorite. (auth)

17382 TESTING OF ASCORBIC ACID BY ACTIVATION ANALYSIS. Zoeld, E.; Toth, G. (Technical Univ., Budapest). Radiochem. Radioanal. Lett.; 9: No. 3, 225-30(22 Feb 1972).

Activation analysis of organic compounds requires careful preparation of the samples because of decomposition occurring during the reactor activation. The reactor irradiation of ascorbic acid for analysis for impurities is described. (auth)

17383 RADIOCHEMICAL SEPARATIONS WITH HALOGENATED RESINS. Heurtebise, M.; Ross, W. J. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Anal. Chem.; 44: No. 3, 596-9(Mar 1972).

The use of halogenated resins permits simple and rapid separation of such ions as I^-, Br^-, Au^{3+}, Hg^{2+}, and Ag^+ in neutron activation analysis. Since these resins require neither the presence of carriers nor constant flow rates, their use is amenable for routine applications. The resins can be reused if stored with the proper halogen reagent and if sufficient time is allowed for complete decay of the activated ions retained in the resin. Bromine and iodine can be determined even in the presence of Au, Hg, and Ag which are also selectively retained in the resin since it is possible to select short irradiations and measure the short-lived isotopes of Br and I. It has been calculated that ^{197}Hg can be determined in the presence of ^{198}Au if their relative concentrations are comparable. Ag interferes only if its concentration is 100 times greater than that of Hg or Au. (auth)

17384 ACTIVATION ANALYSIS OF THE BIOLOGICAL TRACE ELEMENTS. Leddicotte, George W. (Georgia Inst. of Tech., Atlanta). Methods Biochem. Anal.; 19: 345-434 (1971).

A review is presented on activation analysis of the biological trace elements that includes principles and experimental methods, generalities about the activation analysis method, and applications in medicine, dental medicine, pharmacology, studies of land and sea mammals, fish and other marine species, plant sciences, and agriculture. (1027 references) (D.H.M.)

17385 PRODUCTION OF ZIRCONIUM PHOSPHATES FOR THE SEPARATION OF PHOSPHATES IN BIOLOGICAL MATERIALS IN NEUTRON ACTIVATION ANALYSIS. Toeroek, G.; Diehl, J. F. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Radiochim. Acta; 16: No. 2, 106-10(Nov 1971). (In German).

The high phosphorus content of biological materials frequently disturbs the determination of trace elements by activation methods. The usual methods for phosphate removal require excessive work and time and cause losses by coprecipitation. These disadvantages do not apply to the semi-specific sorption on zirconium phosphate preparations. Production methods for various zirconium phosphates are described. With the best preparations, the phosphorus content can be decreased by a factor of 3.5. (H.B.G.)

17386 HUMAN TISSUE TRACE-ELEMENT DETECTION BY NEUTRON ACTIVATION WITHOUT CHEMICAL SEPARATION. Budinger, T. F.; Farwell, J. R.; Smith, A. R.; Bichsel, H. (Univ. of California, Berkeley). Int. J. Appl. Radiat. Isotop.; 23: No. 2, 49-56(Feb 1972).

A method for analysis of 40 trace elements in human tissues without chemical separation involved 8 hr activation at 10^{13} neutrons cm^{-2} sec^{-1} and 10 to 20 days' decay before counting on Ge(Li) detectors. Five human tissues were examined to determine the feasibility of analysis of necropsy and biopsy tissues on a routine basis. The technique has many advantages if tissues are lyophilized and pressed into tablets before activation. (auth)

17387 CHEMICAL COMPOSITION OF A SAMPLE OF THE LUNAR SURFACE BROUGHT BACK BY THE AUTOMATIC PROBE, LUNA 16. Jerome, D. Y. (Univ., Paris); Philippot, J. C.; Brichet, E. Compt. Rend., Ser. D; 273: No. 19, 1657-9 (8 Nov 1971). (In French).

Analysis by nondestructive neutron activation enabled 28 elements to be determined from a sample of the lunar surface obtained from the Mare Foecunditatis. The abundances of 10 rare earths (La, Ce, Nd, Sm, Eu, Tb, Ho, Tm, Yb, and Lu), 11 other minor or trace elements (Sc, V, Cr, Mn, Co, Mo, Ba, Hf, W, Au, and Th), and 7 main elements (Na, Mg, Al, K, Ca, Ti, and Fe) were obtained. Of all the areas of the lunar surface including those analyzed from samples taken during Apollo 11, 12, and 14 experiments, this area contains the least amounts of rare earths (notably Hf and Th); the 4 lunar sites studied are, however, characterized by the consistency in the amount of Eu they contain. (France)

Chemical and Spectral Procedures

Refer also to abstracts 17595, 17598, 17881, and 17882.

17388 (AED-CONF-71-100-56) DESTRUCTIVE NUCLEAR MATERIAL ASSAY. Baeckmann, A. von; Avenhaus, R.; Beyrich, W.; Kraemer, R.; Koch, L.; Mainka, E.; Neuber, J.; Wertenbach, H.; Wilhelmi, M. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany). European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). May 1971. 21p. (CONF-710901-540). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

It appears to be possible in the near future to employ fully automated systems for the direct assessment of nuclear fuels in solutions and powders that would require far less expenditure in terms of control. The capability of the established conventional methods was determined by interlaboratory tests. The methods of isotope dilution mass spectrometry and x-ray fluorescence spectroscopy are described. (auth)

17389 (IEA-242) DIRECT SPECTROPHOTOMETRIC DETERMINATION OF THE URANIUM CONTENT OF THE ORGANIC PHASE OF URANYL NITRATE–TRIBUTYL PHOSPHATE–NITRIC ACID SYSTEM. Federgruen, Ludmila; Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jul 1971. 19p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A procedure is described for the determination of the uranium content in a uranyl nitrate–tributyl phosphate(TBP)–nitric acid solution. The method is based on the direct measurement of the uranyl nitrate in the organic phase. The absorption spectrum of this organic phase is quite rich, the following absorbance maxima being exhibited: 358, 370, 382, 393, 405, 416, 429, 438, 453, 470, and 486 mμ. The 416 mμ peak was chosen for the direct determination of uranium. Interferences from Ce(IV), Th(IV), and Fe(III) were studied; only that from Fe(III) was found to be serious. Fe(III) can be washed out from the organic phase by an approximate scrubbing solution. Uranium can be determined in the 1 to 250 g/l U range, requiring about 15 minutes to run a duplicate. (auth)

17390 (ORNL-4749, pp 51-2) MASS SPECTROMETRY. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

17391 (ORNL-4749, pp 53-5) ELECTRON AND X-RAY PHYSICS METHODS. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

17392 (ORNL-4749, pp 57-9) SPECTROMETRY SERVICES. (Oak Ridge National Lab., Tenn.). Jan 1972.

In Analytical Chemistry Division annual progress report for period ending September 30, 1971.

17393 ATOMIC ABSORPTION DETERMINATION OF THE RARE-EARTH ELEMENTS. Melamed, Sh. G.; Saltykova, A. M.; Chelidze, L. F. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 2, 208-10(Feb 1971).

Translated from Zavod. Lab.; 37: No. 2, 166-8(Feb 1971).

A method of atomic absorption determination of individual rare earth elements in mixtures of the rare earth oxides and Mg–Nd, Mg–Y, Mg–Dy, and Mg–Er alloys was developed using a Perkin–Elmer 303 spectrophotometer; flame $C_2H_2 + N_2O$; length of the absorbing layer of the flame 50 mm. The values that were obtained for the sensitivity and limits of detection for yttrium and for the heavy rare earth elements (Tb–Lu) are close to the values cited in the Perkin–Elmer manual. The reproducibility of the determination of the optical densities for elements in the series La–Gd is substantially poorer than the reproducibility in the series Tb–Lu and yttrium. (D.H.M.)

17394 DETERMINATION OF TOTAL RARE EARTH CONTENT IN NATURAL WATERS BY EXTRACTION–SPECTROPHOTOMETRY METHOD. Poluektov, N. S.; Kirillov, A. I.; Makarenko, O. P.; Vlasov, N. A. (Irkutsk State Univ., USSR. Inst. of General and Inorganic Chemistry, Kiev). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 5, 680-1(May 1971).

Translated from Zavod. Lab., 37: No. 5, 536-7(May 1971).

An extraction spectrophotometric method using rare earth complexes with Arsenazo III and diphenylguanidine in butyl alcohol was applied to quantitative determination of the sum of rare earth elements in various natural waters. The statistically calculated sensitivity of the determination is 0.07 μg/10 ml. Various methods used to eliminate interferences are discussed. (M.C.G.)

17395 DETERMINATION OF NIOBIUM IN ALLOYS BY DIFFERENTIAL SPECTROPHOTOMETRY. Elinson, S. V.; Pobedina, L. I.; Rezova, A. T. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 493-5(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 391-4(Apr 1971).

A differential spectrophotometric method of determining Nb in alloys is proposed; the method is based on obtaining a colored complex with pyridylazoresorcinol in an acid tartrate solution. The method operates successfully for Nb–Ti, Nb–Zr, and Nb–Fe alloys, complex carbides, and other materials containing Nb 10 to 80%. A typical accuracy is 0.5%. (Metals Abstr.)

17396 PHOTOMETRIC DETERMINATION OF MICROQUANTITIES OF COBALT IN STEELS BY MEANS OF ION EXCHANGE. Novak, V. P.; Martynov, A. P.; Mal'tsev, V. F. (All-Union Scientific-Research and Structural Technological Inst. for the Tubing Industry, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 521-2(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 412-13(Apr 1971).

A new method of determining traces of Co in Cr–Ni stainless steels by ion exchange followed by photometric analysis is proposed. The method allows for the separation of the Co from accompanying elements such as Fe, Cr, Ni, Mn, Ti, Mo, and Nb in an ion-exchange column; slight difficulties may be encountered in dealing with the Mo and Nb. The method compares favorably with previous techniques. (Metals Abstr.)

17397 PHOTOMETRIC DETERMINATION OF TELLURIUM IN SULFIDE ORES. Tuan, Dang Chung; Simonova, L. N.; Busev, A. I. (Moscow State Univ.).. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 513-14(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 408-9(Apr 1971.

The photometric determination of Te in sulfide ores in the presence of large amounts of Se is described. The determination is based on the use of 5-mercapto-3-(2-naphthyl)-1, 3, 4-thiadiazolothione-2 and requires no preliminary Se separation. An extraction-photometric determination of Te in the presence of 200 times as much Se is quite feasible. The relative accuracy of the determination is 20%. (Metals Abstr.)

17398 JOINT DETERMINATION OF NITROGEN AND OXYGEN IN TITANIUM AND ITS ALLOYS BY A SPECTRAL ISOTOPIC METHOD. Dudich, G. K.; Petrov, A. A.; Favorskaya, M. P. (Leningrad State Univ.). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 556-(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 436-7(Apr 1971).

A technique for simultaneously determining N and O in Ti and Ti alloys by a combination of isotope exchange (using ^{15}N and ^{18}O in the form of CO_2) and spectral analysis is described. The sensitivity is 5×10^{-4} wt.% O and 10^{-4} wt.% N. The reproducibility of the results equals 10% for O and 20% for N. Some typical test results are presented. (Metals Abstr.)

17399 DETERMINATION OF TRACES OF RARE EARTHS AND YTTRIUM IN TUNGSTEN MINERALS. Kolenko, L. I.; Nedler, V. V.; Pokrovskii, P. V.; Chervyakovskaya, V. V. (Inst. of Geology and Geochemistry, Sverdlovsk, USSR). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 541-3(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 425-8(Apr 1971).

A combination of chemical and spectral methods is presented for the determination of rare earths and yttrium in tungsten minerals. A modified oxalate method was used to concentrate the rare earths. The rare earth concentrates prepared from tungstates usually contain up to 10% each of Fe, Mn, Ti, and Ca resulting in errors from interfering lines. These difficulties are largely overcome if the concentrate is diluted 1:19 with carbon powder and then mixed 1:1 with a buffer mixture consisting of carbon powder containing 20% barium fluoride and 0.02% Sc_2O_3. (D.H.M.)

17400 ANNULAR COLORIMETRY OF SOME FERROUS ALLOYS. Armeanu, V.; Niculescu, Ileana (Chair of Chemistry and Physics, Bucharest. Polytechnic Inst., Bucharest). Rev. Roum. Chim.; 16: No. 12, 1867-70(Dec 1971).

Alloys of Fe–Ni–Cr, Fe–Mn, Fe–V, Fe–Mo, and Fe–W were studied electrographically; filter paper and various electrolytes were used as support. The contact time, the difference of potential and the electrolyte (nature and quantity) varied and a ring-oven was used for the analysis of the electrographic samples. Various reagents, specific to each element, were studied. The rings obtained were visually compared with standard rings, and then read to a densitometer, reaching a precision of the order of semiquantitative methods. (auth)

17401 TRACER METHOD USING STABLE ISOTOPES OF SULFUR. Newman, L.; Smith, M.; Forrest, J.; Tucker, W.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). pp 16-25 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

An isotope ratio tracer method was developed employing a dual-beam isotope ratio mass spectrometer to measure the ratio of sulfur-32 or sulfur-34 in sulfur samples. It depends upon the natural variation in the ratio in sulfurs from different sources to characterize them. Sulfur hexafluoride was also applied to plume dispersion studies. The measurements are sensitive enough to measure the changes with adequate precision to indicate the degree of conversion that has occurred in the ratio of sulfur-32 to sulfur-34 that result from isotopic exchange following chemical reaction. The oxidation of sulfur dioxide in a plume emanating from a 370-MW oil-fueled plant appears to follow a pseudo second order mechanism. The rate constant for the reaction is approximately 1 hr^{-1} ppM^{-1}. Sampling is accomplished with a filter pack consisting of an 8'' × 10'' glass fiber filter that collects sulfate particulates, followed by a fast-flow cellulose filter paper impregnated with an aqueous solution of 20% potassium hydroxide and 10% triethanolamine to absorb SO_2. The filter pack is used in conjunction with a conventional high-volume sampler. In sampling aloft the equipment can be mounted in a plane which will fly across the plume at a right angle to its direction of movement. The samples are processed to silver sulfide and then combusted with oxygen of constant isotopic composition, to form SO_2. (auth)

17402 DETERMINATION OF SELECTED TRACE ELEMENTS IN WATER SAMPLES USING SPARK SOURCE MASS SPECTROSCOPY AND NEUTRON ACTIVATION ANALYSIS. Wahlgren, M. A.; Edgington, D. N.; Rawlings, F. F. (Argonne National Lab., Ill.). pp 97-103 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

A set of 30 water samples from tributaries to the South Basin and Green Bay regions of Lake Michigan have been analyzed by spark source mass spectroscopy of 20 selected trace elements of radiological, biological, and geochemical interest including B, I, Pb, and U. During the method development, the precision of analysis was improved from ~40% to ~20% by optimizing the sample handling and mass spectrographic techniques. The neutron activation analysis techniques which will be used to analyze these and similar samples for intermethod comparison are described. The precision of the mass spectrographic analysis has been found to be adequate for most environmental water chemistry problems, but further study will be required to evaluate the accuracy which can be attained. (auth)

17403 COMPLEX EXCHANGE-REACTION FOR THE INDIRECT SPECTROPHOTOMETRIC AND ATOMIC-ABSORPTION SPECTROMETRIC DETERMINATION OF TRACE ELEMENTS. Jackwerth, E.; Graffmann, G. (Institut fuer Spektrochemie und Angewandte Spektroskopie, Dortmund, Ger.). Z. Anal. Chem.; 257: No. 4, 265-8(1971). (In German).

A method is described for the quick and sensitive determination of a number of trace elements including La, Zr, Ce, and Th in solution if the respective element is alone present. The chelate complex of diethylenetriaminepentaacetate (DTPA) with divalent copper $[CuDTPA]^{3-}$ is used as an exchange reagent. In presence of an additional complexing reagent selective for copper, i.e., bathocuproine, cations can be exchanged against an equimolar quantity of copper, even when they form weaker DTPA complexes than copper does. The copper–bathocuproine complex formed in equilibrium by addition of a metal ion is extracted into n-hexanol. The extract is then analyzed by spectrophotometry or by atomic absorption spectrometry. For all cations determined photometrically the relatively high molar extinction coefficient of 1.2×10^4 $l \times mol^{-1} \times cm^{-1}$ is valid. For the use of atomic absorption spectrometry the exchange reaction increases the sensitivity for some elements by more than 2 powers of ten. (auth)

17404 CYCLIC VOLTAMMETRY OF Pu AND Np IN NITRIC ACID MEDIA. Casadio, Sergio; Orlandini, Franco (CNEN-CSN, Rome). J. Electroanal. Chem. Interfacial Electrochem.; 33: No. 1, 212-15(Nov 1971).

The behavior of Pu and Np electrodes in nitric acid solution at pyrolytic graphite working electrodes was characterized in order to investigate by cyclic voltammetry the analytical applications of the monoelectronic and multistage charge transfers given by the various ionic species of these two elements. (M.C.G.)

17405 CHEMICAL ANALYSIS OF RARE ELEMENTS BEARING MINERAL ALLUVIAL CONCENTRATES. Jeczalik, Augustyn (Inst. of Geology, Warsaw). Chem. Anal. (Warsaw); 16: No. 6, 1271-8(1971). (In Polish).

Principal operations and optimum parameters are given for the methods of determination of Be, Sn, Zr, Li, Nb_2O_5, Hg, TiO_2, W, rare earth oxides, and Au in concentrates, containing minerals of the above elements, the concentrates being raw materials for these elements. The analytical schemes presented, together with the literature cited, may be useful in the adaptation of the methods for the routine determination of the elements mentioned above. (auth)

17406 ISOTOPIC STUDY OF HOT SPRINGS IN JAPAN. 1. TECHNIQUES FOR OXYGEN ISOTOPIC ANALYSIS OF SPRING WATERS. Matsubaya, Osamu; Sakai, Hitoshi; Tanaka, Hinako; Uemura, Tazue (Okayama Univ., Tottori, Japan). Okayama Daigaku Onsen Kenkyusho Hokoku; No. 40, 33-40(Mar 1971). (In Japanese).

The CO_2-H_2O isotopic equilibration technique was studied for the routine analyses of the oxygen isotopic ratios of hot spring water. A reaction vessel containing 2 ml of water and 0.16 m mole of tank CO_2 was shaken for 18 hrs in a constant-temperature bath at 25.0°C and the CO_2 was analyzed for the oxygen isotopic ratio by a McKinney-type mass spectrometer. Several aliquots of 1, 2, and 5 ml from the same water were each analyzed three times by successive equilibration. The observed values differ depending on the volume of water but the corrected values by an equation indicate excellent agreement, implying the whole processes to be well controlled. The reproducibility of the isotopic analyses is better than ±0.1‰ in most cases, and the accuracy would not be worse than ±0.2‰ as demonstrated by the interlaboratory comparison of some standard samples. Oxygen isotopic ratios of water from more than 70 hot springs in Japan are presented. Most hot spring water has the $\delta\ ^{18}O$ values similar to those of meteoric waters in Japan. However, spring water from Arima Hot Springs, Hyogo-Pref., which has been known by its abnormally high chloride and low sulfate concentrations is of an exceptionally high $\delta\ ^{18}O$ value. (auth) (Japan)

17407 CHROMATOGRAPHIC ANALYSIS OF CATIONS OF THE SECOND ANALYTICAL GROUP IN THE SYSTEM: LIQUID ANION EXCHANGER/HYDROCHLORIC ACID. I. SUBGROUP IIA. Flieger, Anna; Przeszlakowski, Stanislaw (Dept. of Inorganic and Analytical Chemistry, Lublin, Poland). Chem. Anal. (Warsaw); 16: No. 6, 1341-6(1971). (In Polish).

Reversed phase paper chromatography was used for the qualitative determination of cations of the second analytical group [Hg(II), Pb, Cd, Cu(II), Bi, Os(III), Ru(III), Pd(II), Re(VII)]. Whatman No 4 paper strips were impregnated with 0.1M benzene solution of Amberlite LA-1 hydrochloride and after the evaporation of benzene they were developed with 6 N aqueous solution of hydrochloric acid. The individual ions were identified utilizing differences between R_F values and selective color reactions with the following reagents: 1. thiourea (Os, Ru, and Bi), 2. $SnCl_2$ + KSCN (Pd, Hg, and Re), 3. $Na_2S + NH_3 \cdot H_2O$ + KCN (Pb and Cd), 4. cuprone (Cu), 5. $KBiJ_4 + As_2O_3 + NaHCO_3$ (Pb). The time of complete analysis of the mixture of ions depends on the chromatographic technique used and amounts to 1 hr 15 min for the descending technique, 1 hr for the circular technique and 3.5 hr for the Matthias' method. Sensitivities of color reactions for the metals investigated under the chromatographic conditions used were also determined. (auth)

17408 EMISSION SPECTROGRAPHIC DETERMINATION OF AMERICIUM IN CURIUM OXIDE. Gaddy, R. H. (Savannah River Lab., Aiken, S. C.). Appl. Spectrosc.; 26: No. 1, 49-51 (Jan-Feb 1972).

Emission spectrographic procedures were developed for determining americium in high-purity oxide and in mixed americium and curium oxides containing 33 to 60% americium. (auth)

17409 DETERMINATION OF URANIUM IN HIGH-GRADE URANIUM CONCENTRATES BY AN X-RAY EMISSION SPECTROGRAPHIC METHOD. Jensen, Chester L.; Baur, Gretta S. (Salt Lake City Metallurgy Research Center). Appl. Spectrosc.; 26: No. 1, 57-9(Jan-Feb 1972).

A fast, precise, and accurate x-ray emission spectrographic method was developed for the determination of uranium in high-grade (70% to 99% U_3O_8) uranium concentrates. No chemical separations are required. After acid decomposition, yttrium is added as an internal standard, and the uranium in dilute acid solution is determined by x-ray emission techniques. The standard deviation obtained for the average of the mean by analysis of six portions of the same sample is 0.03% U_3O_8. Such precision is equivalent to that of the more complicated titrimetric methods conventionally used. (auth)

17410 ARC SPECTRAL LINES OF SELENIUM AND TELLURIUM. Mellichamp, J. W.; Vezzoli, G. C. (Inst. for Exploratory Research, Fort Monmouth, N. J.). Appl. Spectrosc.; 26: No. 1, 105-6(Jan-Feb 1972).

The apparatus and excitation conditions for obtaining the spectra of Se and Te are given. Wavelengths and relative intensities of Se and Te lines produced under these conditions are compared with published tables. (M.C.G.)

17411 ANALYTICAL APPLICATION OF ALKYL PHOSPHORIC ESTERS. IX. Mohai, Miklosne; Upor, Endre. Magy. Kem. Foly.; 77: No. 11, 553-5(Nov 1971). (In Hungarian).

A method is presented for determining small quantities of thorium and zirconium in rare earth preparations, and is based on the light absorption of Arsenazo III complexes with Th and Zr. A preliminary separation of Th and Zr from rare earth elements was accomplished by an extraction with 0.01M DBP from 4N HCl solution. Breaking down the DBP with HBr leaves the Th and Zr in the aqueous phase. If the determination of Th only is desired, re-extraction (in lieu of the HBr treatment) by added TBP takes advantage of an antagonistic effect. (tr-auth)

17412 NIOBIUM, MOLYBDENUM, HAFNIUM, TUUNGSTEN, THORIUM, AND URANIUM IN LICHENS AND MOSSES. Eraemetsae, O.; Yliruokanen, I. (Helsinki Univ. of Tech., Otaniemi, Finland). Suomen Kem.; 44: No. 11, 372-4P1971).

The contents of Nb, Mo, Hf, W, Th, and U in the ash of 12 lichen samples (6 species) and 22 moss samples (11 species) were determined by spark source mass spectrography. The contents of niobium were usually 1 to 20 ppM, of molybdenum 1 to 20 ppM, of hafnium 1 to 19 ppM, of tungsten 1 to 40 ppM, of thorium 0.5 to 29 ppM, and of uranium 1 to 7 ppM in the ash. 15 to 170 ppM Nb were present in samples from a carbonatite phoscorite deposit and 65 to 4900 ppM U in samples from an abandoned uranium mine. (auth) (Finland)

17413 SPECTROPHOTOMETRIC DETERMINATION OF CALCIUM IN ZIRCONIUM POWDER BY USE OF MUREXIDE. Gordon, Herman; Norwitz, George (Frankford Arsenal, Philadelphia). Talanta; 19: No. 1, 7-14(Jan 1972).

An accurate spectrophotometric method is proposed for the determination of calcium in zirconium powder by use of murexide. A 0.4 g sample is dissolved in hydrofluoric and sulphuric acids, the solution evaporated to fumes of sulphuric acid, and a mercury cathode electrolysis made if more than 0.05% copper or nickel is present. Ammoniacal precipitation in the presence of ammonium chloride separates zirconium and other elements and an aliquot of filtrate is collected, equivalent to 0.2 g of sample. The ammonium salts are destroyed with nitric and hydrochloric acids and the calcium is determined with murexide. The high reagent blank is shown to be due to the reagent grade nitric acid, hydrochloric acid, and ammonium hydroxide. (auth)

17414 SUCCESSIVE COMPLEXOMETRIC DETERMINATION OF THORIUM AND URANIUM IN SULPHURIC ACID MEDIA. Khosla, M. M. L. (Defence Lab., Jodhpur, India); Rao, S. P. Talanta; 19: No. 1, 71-4(Jan 1972).

A selective analytical extraction method for rapid successive complexometric determination of thorium(IV) and uranium(VI) in sulfuric acid media is described. The method is based on the extraction of thorium and uranium from sulphuric acid media with N-butylaniline or N-benzylaniline in chloroform. Both thorium and uranium are selectively and quantitatively extracted in the presence of ascorbic acid and EDTA. Most cations and anions do not interfere. The reduction of uranium(VI) with sodium dithionite at room temperature is rapid and quantitative and superior to that with ascorbic acid, which reduces uranium(VI) in boiling solution. The method is simple, rapid, and accurate, and the experimental conditions are not highly critical. (auth)

17415 IODOGRAVIMETRIC METHODS IN ORGANIC ELEMENTAL ANALYSIS. X. DETERMINATION OF HALOGENS IN THE PRESENCE OF SULFUR, ALKALI, AND ALKALINE EARTH METALS. Kozlowski, Edmund; Kobylinska-Mazurek, Barbara (Inst. of Chemical Engineering and Measuring Techniques, Dan-

zig). Chem. Anal. (Warsaw); 16: No. 6, 1169-78(1971). (In French).

The purpose of this work was to enlarge the scope of halogen iodogravimetry on organic compounds containing sulfur, alkali metals, and alkaline earth metals. It was shown that MgO can be used as a selective reagent for the quantitative absorption of the products of sulfur oxidation in a combustion tube at a temperature of ~700°C in the stream of moist oxygen. Thus halogens can be gravimetrically determined in organic compounds in terms of their iodine equivalent. Standard deviation amounted to ±0.16 and ±0.23% absolute for the determination of Cl and Br, respectively. Halogens in some alkali metal or alkaline earth metal halides can be determined by mixing the substance analyzed with ammonium bisulfate. In this case it is possible to determine simultaneously the metal as M_2SO_4 residue in the weighing boat. (auth)

17416 SEPARATION OF MOLYBDENUM BY SOLVENT EXTRACTION FROM FISSION PRODUCTS OF URANIUM FOR MASS SPECTROMETRIC ANALYSIS. Krtil, J.; Bulovic, V.; Moravec, A. (Inst. of Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 9: No. 3, 213-20(22 Feb 1972).

A method for the isolation of the stable isotopes of molybdenum from a mixture of uranium fission products, based on extraction with di(n-octyl) phosphate from strongly acidic solutions is described. (auth)

17417 SPECTROPHOTOMETRIC STUDY OF THE REACTION OF MOLYBDENUM(VI) WITH HALOBENZOPHENONE. Popa, G.; Dumitrescu, V.; Ciurea, I. C. (Univ., Bucharest). Chim. Anal.; 1: No. 4, 215-17(Oct-Dec 1971). (In Rumanian).

The complex Mo(VI) with halobenzophenone was studied spectrophotometrically and it was established that in a slightly acid medium, pH = 4.6, the combination ratio Mo(VI)/reactant was ½. The instability constant of the complex, obtained by the method of Job's nonisomolar series methods is 6×10^{-6}. On the basis of this study, a spectrophotometric method for determination of Mo(VI) between the concentration limits of 0.2 to 4 μg Mo(VI)/cm³ was worked out. The determinations are made at a pH of 4.6 and a wavelength of 380 mm; the molar absorption coefficient is 14,400. (auth)

17418 DETERMINATION OF TECHNETIUM BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Hareland, Willard A.; Ebersole, Earl R.; Ramachandran, T. P. (Argonne National Lab., Idaho Falls, Idaho). Anal. Chem.; 44: No. 3, 520-3(Mar 1972).

The atomic absorption characteristics of technetium were investigated with a laboratory-constructed technetium hollow-cathode lamp as a spectral line source. The sensitivity for technetium in aqueous solution is 3.0 μg/ml in a fuel-rich acetylene–air flame for the unresolved 2614.23–2615.87 Å doublet under the optimum operating conditions. The absorption of spectral radiation was studied as a function of wavelength, fuel-to-oxidant ratio, hollow-cathode lamp current, burner height, and spectral bandwidth. Studies with 32 cations at concentrations of 50 and 500 μg/ml indicated that only calcium, strontium, and barium caused severe technetium absorption suppression with 60 μg/ml of technetium in 2N hydrochloric acid solutions. The cationic interferences are eliminated by adding aluminum to the test solutions. The applicability of atomic absorption spectrophotometry to the determination of technetium in uranium and a uranium alloy was demonstrated. (auth)

17419 HOMOGENIZATION OF NONCONDUCTING SAMPLES FOR SPARK SOURCE MASS SPECTROMETRIC ANALYSIS. Morrison, G. H.; Rothenberg, A. M. (Cornell Univ., Ithaca, N. Y.). Anal. Chem.; 44: No. 3, 515-20(Mar 1972).

A method was developed for the homogenization of powdered geological samples for use in spark source mass spectrometry. Uniform blending with high purity graphite has been achieved and precision of analysis of ±10% attained. In the application of the procedure to material from the meteorite Allende, 28 elements were determined with an average precision of ±7%. (auth)

17420 TITRIMETRIC DETERMINATION OF URANIUM WITH ELECTROGENERATED VANADIUM(V). Goldbeck, Clara Gale; Lerner, Morris W. (Atomic Energy Commission, New Brunswick, N. J.). Anal. Chem.; 44: No. 3, 594-6(Mar 1972).

Modification of the titrimetric determination of uranium using V(V) as titrant is described: the titration with electrogenerated V(V). The modification is of particular value for refining the automatic procedure. (D.H.M.)

17421 SELECTIVE EXTRACTION SPECTROPHOTOMETRIC DETERMINATION OF URANIUM WITH CHLOROPHOSPHONAZO III. Guertler, Oswald (Karl-Marx Univ., Leipzig); Holzapfel, Heinz; Chu-Xuan-Anh. Z. Chem.; 11: No. 10, 389-90 (Oct 1971). (In German).

To solutions containing uranium, Chlorophosphonazo III was added. A mixture of 4:1 n-butanol–benzyl alcohol was then added and the sample shaken for one minute. Fifteen minutes later, the organic phase was removed by filtration. Uranium content was determined by colorimetry at 670 nm. Results of the method were distorted in the presence of thorium, zirconium, rare earth metals, iron(III), and several other metal ions. To eliminate such disturbances, a prior extraction was performed with triphenylarsine oxide in the presence of $NaNO_3$ and EDTA. The method was excellently suited for determination of uranium traces in the presence of many other ions. Under proper conditions, 50 ng/ml ± 30% uranium could be detected reproducibly. (H.B.G.)

17422 COMMENTS ON CHRONOPOTENTIOMETRIC AND ELECTRODE POTENTIAL INVESTIGATIONS IN MOLTEN EQUIMOLAR SODIUM AND POTASSIUM METAPHOSPHATES. Lieto, L. R.; Johnston, R. O. Jr. (Univ. of Illinois, Urbana). Anal. Chem.; 44: No. 3, 636(Mar 1972).

From a study of the validity of the diffusion model in a highly viscous metaphosphate system it was concluded that for U(IV), U(VI), and Cu(I) the reversible diffusion-controlled model as put forth by Wolfe and Caton (Anal. Chem. 43, 663, (1971)) does not apply. (D.H.M.)

17423 DEVICE FOR SPECTROGRAPHIC ANALYSIS OF SUBSTANCES. Blum, Pierre; Spitz, Jean (to Commissariat a l'Energie Atomique). British Patent 1,258,150. 22 Dec 1971. Priority date 18 Dec 1968, France.

A device is described for particular use in spark spectrographic analysis of samples such as particulate materials filtered from air samples. The device comprises a turntable adapted to carry the substance to be analyzed in a horizontal plane and mounted on a movable carriage, an elongated electrode extending vertically above the turntable, and a motor that serves to drive the turntable in rotation about its own axis and at the same time to drive the carriage in rectilinear translational motion at right angles to the axis of the electrode. These combined motions of the turntable result in a point on the surface of the turntable describing a spiral path. The turntable rotates at a speed so that passage of points on the surface is constant relative to the electrode. The main object of the analysis is to detect the presence of such particles as Th, U, and Be. (B.L.M.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 17763, 17780, 17781, 17784, 17803, 17815, 17856, 17919, 17927, and 17928.

17424 (JUL–801-RG) ANALYSIS OF COMPLEX β-SPECTRA ESPECIALLY FOR THE DETERMINATION OF STRONTIUM-90 IN FISSION PRODUCT MIXTURES. Mioduszewski, Peter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Oct 1971. 65p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

In order to detect ^{90}Sr in a mixture of fission products there exists, apart from the chemical separation, another possibility to analyze the complex β-spectrum of fission products, because ^{90}Sr is a pure β-radiator. Different possibilities are given to evaluate complex β-spectra. Especially, the Kurie-analysis, the method with standard-spectra, and a discriminator-procedure are studied and compared. It was shown that for series investigations with the known composition of β-spectra, as is required for the determination of strontium concentration profiles in coated particles, the discriminator procedure is most appropriate because of its high sample throughput and the simple analysis. (auth)

17425 (MLM–1829) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT, APRIL–JUNE 1971. (Mound Lab., Miamisburg, Ohio). 13 Jan 1972. Contract AT-33-1-GEN-53. 42p. Dep. NTIS.

EXPLOSIVES—analysis of PBX-9007, for plasticizer
INDIUM-113—production of isomeric, from tin-113 generator, residue adsorption separation method for
PLUTONIUM—stability of heptavalent, in water solution
—reactions with hydrogen peroxide
—determination in soil by fusion method
PLUTONIUM OXIDES PuO_2—analysis for impurities by carrier distillation
PROTACTINIUM-231—determination in airport cake samples by γ spectroscopy
THORIUM—determination in plutonium dioxide by x-ray fluorescence

WATER—determination of tritiated, in stack effluent samples, method for (E.J.H.)

17426 RADIOISOTOPIC METHOD FOR THE ANALYSIS OF AIR IMPURITIES IN HELIUM. Bukolov, V. I. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 593-4(Apr 1971).
Translated from Zavod. Lab.; 37: No. 4, 462-3(Apr 1971).

A technique is presented for the determination of air impurity in helium by the measurement of the saturation ionization current. A cylindrical ionization chamber with electrodes of 5- and 11-mm diameter was used in these experiments. The source of α-radiation was ^{239}Pu. The amount of impurity due to other gases in the helium used did not exceed 0.05%. (D.H.M.)

17427 USE OF THE CALIBRATION TECHNIQUE IN THE X-RAY FLUORESCENCE DETERMINATION OF RARE-EARTH ELEMENTS. Renev, V. K.; Bagaev, N. V.; Troneva, N. V.; Antonov, A. V. (State Scientific-Research and Design Inst. of the Rare-Metal Industry, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 533-5(Apr 1971).
Translated from Zavod. Lab.; 37: No. 4, 418-20(Apr 1971).

Calibration techniques suitable for use in the x-ray fluorescence determination of rare earth metals in industrial processing products are described and discussed. The underlying theoretical equations are derived and a method of successive approximations facilitating the experimental determination of the parameters and coefficients in these equations is presented. An accuracy of 5 to 7% is typical. (Metals Abstr.)

17428 DETERMINATION OF CARBONATE-^{14}C BY LIQUID SCINTILLATION COUNTING. Kuyper, Adrian C.; Aghdashi, M. (Wayne State Univ., Detroit). Anal. Biochem.; 45: No. 1, 341-3(Jan 1972).

In order to avoid errors in the scintillation counting of radioactive carbonate caused by the insolubility of carbonate salts in scintillation solutions, a method was developed for preliminary distillation of radioactive carbon dioxide into an organic base. The method is simple, accurate, and well adapted to measurement of radioactive CO_2 formed in metabolism. (J.G.B.)

17429 ELEMENTAL ANALYSIS OF SMOG BY CHARGED PARTICLE BEAMS: ELASTIC SCATTERING AND X-RAY FLUORESCENCE. Cahill, T. A.; Sommerville, R.; Flocchini, R. (Univ. of California, Davis). pp 26-9 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).
From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

Elemental analysis by charged particle beams provides a useful method for investigating atmospheric aerosols. Two techniques involving charged particle beams, elastic scattering and excitation of x-rays by alpha particles, are evaluated. An aerosol analysis system based on these techniques is described. (auth)

17430 MASS SPECTROMETRY AND FISSION TRACK ANALYSIS IN NUCLEAR ENVIRONMENTAL MEASUREMENTS. Myers, Willard G.; White, Frederick A. (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 38-43 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).
From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

It appears that mass spectrometry and fission track techniques can be employed in a complementary fashion for assaying trace quantities of the fissile nuclides, Th, U, and Pu. An investigation was made to determine the concentration of uranium in surface air at urban and rural locations within New York State by applying these methods. Average uranium concentrations ranged from 0.10 to 1.47 ng/m^3 (0.035 to 0.47 fCi/m^3), with each area indicating that a significant correlation exists between the uranium concentration and the density of total suspended particulates. Present levels of uranium in the air environment are attributed primarily to naturally occurring uranium sources and nonnuclear industrial activity. In the immediate vicinity of a nuclear fuel reprocessing plant, a slight excess uranium has been detected by observing the degree of ^{235}U enrichment. The isotopic data obtained via the mass spectrometric analysis points up its potential in such environmental studies. (auth)

17431 ANALYSIS AND PUBLIC HEALTH ASPECTS OF ENVIRONMENTAL TRITIUM. Moghissi, A. A. (Dept. of Health, Education, and Welfare, Montgomery, Ala.). Advan. Chem. Ser.; No. 93, 419-26(1970).
From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

An advanced dioxane-based liquid scintillation solution is developed, which incorporated 5 ml of water and yields a Y value of approximately 1 nCi/liter [Y = $\sqrt{\text{background (c.p.m.)}}/2.22 \times$ volume of water (ml.) $\times$ efficiency (c.p.m./d.p.m.)]. A detergent, Triton-101, in association with p-xylene is used for the suspension of 10 ml. of water with a Y value of approximately 0.5 nCi/liter. The application of an instrumental technique with three photomultipliers decreases further the Y value of both mixtures. A Teflon cylinder with a volume of 250 to 300 ml is used as sample container for low-level counting with a Y value of approximately 0.2 nCi/liter. Selected results of samples collected during 1967 are reported, and the radiation dose to the population of the United States from tritium is estimated to be approximately 0.2 mrem/year. (auth)

17432 ^3H-TOLUENE, ^3H-WATER, AND ^3H-HEXADECANE AS INTERNAL STANDARDS FOR TOLUENE- AND DIOXANE-BASED LIQUID SCINTILLATION COCKTAILS. Hendee, W. R.; Ibbott, G. S.; Crusha, K. L. (Univ. of Colorado, Denver). Int. J. Appl. Radiat. Isotop.; 23: No. 2, 90-5(Feb 1972).

The accuracy of the technique of internal standardization for determination of activity from count rates measured for liquid samples depends on the validity of the assumption that the addition of the standard to the sample causes no change either in the degree of quenching or in other conditions that influence the counting efficiency. Results of six combinations of scintillation solutions composed of toluene plus 0.3% PPO and dioxane plus 0.5% PPO and 10% naphthalene with three internal standards, ^3H-toluene, ^3H-water and ^3H-hexadecane are shown. No change in counting efficiency with increasing volume of added standard was seen except in the case of ^3H-water in toluene-based solution. This combination was also the only one that showed variation in efficiency as a function of time after preparation of the mixture. It is suggested that similar studies should be undertaken whenever a sample or standard is thought to influence the counting efficiency of a solution measured by internal standardization. (UK)

17433 IMPROVEMENTS IN RADIOMETRIC ANALYSIS. Starnes, Peter Edward (to Hilger and Watts Ltd.). British Patent 1,259,771. 12 Jan 1972. Filed 27 Oct 1967.

A method of analysing slurry material by means of x-ray fluorescence analysis is described that renders insignificant some of the errors that arise in conventional x-ray analysis due to fluctuations in chemical composition, and particle size distribution, of the solids. In addition to measurement of the intensity of the characteristic x rays emitted by the material, the slurry material is subjected to at least two absorption measurements. One of these is a measurement of the intensity of radiation, characteristic of the sought element, emitted by a target that is separated from the source of primary radiation and from the radiation detector by an absorption cell through which the slurry is flowing, so that the incident radiation passes through the absorption cell before being measured. The second comprises measurement of the absorption of a beam of 600- to 3000-keV γ radiation directed on a column of the slurry, whereby the sum of the effective values of the mass absorption coefficients of the slurry for both incident and emitted characteristic radiations is determined. A measurement is also made of background radiation from the absorption cell with the sample slurry flowing therethrough without the target in position. At least one standardizing measurement is made in which the absorption cell is replaced by a standard absorber. Apparatus for conducting the measurements is described. (UK)

17434 REMOTE CHEMICAL ANALYSIS DURING THE APOLLO 15 MISSION. Adler, Isidore (Goddard Space Flight Center, Greenbelt, Md.); Trombka, Jacob I.; Gorenstein, Paul. Anal. Chem.; 44: No. 3, 28A-35A(Mar 1972).

X-ray fluorescence, γ, and α experiments for analysis of lunar materials in the Apollo 15 mission are discussed. Orbital remote sensing, radiation environment at the lunar surface, lunar x-ray fluorescence experiment, alpha particle emission experiment, and the scientific instrument module are described. (M.C.G.)

17435 DETERMINATION OF FREE ^{99m}Tc IN LABELLED COMPOUNDS BY MEANS OF THIN-LAYER CHROMATOGRAPHY. Mitta, A. E. A. (Argentina National Atomic Energy Commission, Buenos Aires); Alvarez-Cervera, J.; Raban, P. pp 67-9 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).
From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

A simple and rapid method using thin-layer chromatography for determination of the radiochemical purity of the most widely used ^{99m}Tc-labeled radiopharmaceuticals is described. For a faster

radiometric evaluation of chromatograms, the use of a scintillation camera is proposed. Through these procedures, radiochemical purity can be checked within 5 to 30 min after the preparation of the labeled compound. (auth)

Separation Procedures

Refer also to abstracts 17468, 17587, 17588, 17637, and 17638.

17436 (AERE-R-5987) COMPARATIVE STUDY OF ELECTRODEPOSITION OF ACTINIDES FROM AQUEOUS AMMONIUM SULPHATE AND ISOPROPYL ALCOHOL. Rudran, K. (Atomic Energy Research Establishment, Harwell (England)). 1969. 12p. Dep. NTIS (U. S. Sales Only).

A study was made of the relative merits of electrodeposition of actinide elements from aqueous acid solutions of ammonium sulfate and from isopropyl alcohol (molecular plating). Parameters investigated include the pH of the electrolyte, time of deposition, and the effect of trace amounts of iron. It is concluded that, although electrodeposition from the acid ammonium sulfate electrolyte is more versatile than previously believed, molecular plating electrodeposits quantitatively a wider range of actinides in a shorter time. (auth)

17437 (IS-T-492) USE OF ALIPHATIC α-HYDROXYOXIMES FOR THE SEPARATION OF METAL IONS. Beuerman, Donald Roy (Ames Lab., Iowa). Nov 1971. Contract W-7405-eng-82. 112p. Dep. NTIS.

Thesis.

A straight chain and a branch chain α-hydroxyoxime, 10-hydroxyeicosan-9-oxime (HEO) and 5,8-diethyl-7-dodecanone-oxime (DHDO) respectively, were investigated to determine their usefulness in the quantitative separations of metal ions from aqueous solutions. Paper chromatography was used to rapidly determine interactions between metal ions and the oxime substrates and point out possible separation systems. The distribution coefficients of metals having strong interactions with the oximes were determined at various oxime and proton concentrations. Graphical interpretation of these data, supported by NMR and infrared spectra of the metal-oxime complexes gave some insight into the structure of the complexes. (auth)

17438 PAPER CHROMATOGRAPHY OF HALIDE AND THIOCYANATE COMPLEXES OF METALS USING SOLUTIONS OF LIQUID ANION EXCHANGERS AS MOBILE PHASES. Przeszlakowski, Stanislaw (Medical Academy, Lublin). Chromatogr. Rev.; 15: No. 1, 29-91(Oct 1971).

A review is presented of the paper chromatography of halide and thiocyanate complexes of metals including the use of liquid ion exchangers in the separation and purification of metals a description of materials and method (direct phase chromatography–moist paper technique). The parameters influencing the partition of metals between the aqueous phase and organic phase were investigated including the type and concentration of ligand in the aqueous phase, the type and concentration of amine salts in the organic phase, and the diluents of amines. (214 references) (D.H.M.)

17439 SYNERGISTIC AND ANTAGONISTIC EFFECTS IN THE EXTRACTION OF ^{175,181}Hf(IV) BY DIBUTYL PHOSPHATE (HDBP) AND DI(2-ETHYLHEXYL) PHOSPHATE (HDEHP) IN THE PRESENCE OF TRIOCTYLPHOSPHINE OXIDE (TOPO) OR TRIOCTYLAMINE (TOA) IN HEXANE AND TOLUENE. Liem, Djiet Hay; Sinegribova, Oksana (Royal Inst. of Tech., Stockholm). Acta Chem. Scand.; 25: No. 1, 301-22(1971).

The extraction was studied of ^{175,181}Hf(IV) from 1.0(0.5) M H_2SO_4 and 1.0 M $HClO_4$ aqueous solution into hexane and toluene by dibutyl phosphate (HDBP) or di(2-ethylhexyl) phosphate (HDEHP), in the presence of trioctylphosphine oxide (TOPO), or trioctylamine (TOA). The results show that the combination HDEHP + TOA may cause antagonistic, while HDBP + TOPO may cause both synergistic and antagonistic effects in hafnium extraction. The distribution data were analyzed with the LETAGROPVRID computer program. They indicate the formation of the following extractable Hf(IV)-species: (1) in hexane with HA = HDBP and B = TOPO: HfA_4, $HfA_4(HA)$, $HfSO_4A_2(HA)_2$, $HfSO_4A_2(HA)_3$; $Hf(SO_4)_2B$, $Hf(SO_4)_2B_2$, $Hf(SO_4)_2B_3$; $Hf(ClO_4)_4B_2$, $Hf(ClO_4)_4B_3$; $Hf(SO_4)_2HAB$, $Hf(SO_4)_2HAB_2$, $Hf(SO_4)_2HAB_3$, HfA_4B; $Hf(ClO_4)_3AB_3$; and $Hf(ClO_4)_2A_2B_2$. (2) in toluene with HA = HDEHP and B = TOA: $HfA_4(HA)$, $HfA_4(HA)_2$, $(BH)_2Hf(SO_4)_3$, and $(BH)_2Hf(SO_4)_2A_2$. A summary of the equilibrium constants for the formation of the various Hf(IV)-species is given. (auth) (Denmark)

17440 EXTRACTION METHOD OF THE SEPARATION OF PLATINUM FROM THE OTHER PLATINUM METALS. Ivanova, S. N.; Gindin, L. M.; Shelpakova, I. R.; Toloknova, V. N.; Yudelevich, I. G. (Inst. of Neorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 2, Ser. Khim. Nauk; No. 1, 145-8(Jan 1971). (In Russian).

The extraction method of the separation of platinum from palladium, rhodium, iridium, and ruthenium is suggested. Tetraoctylammonium perchlorate is used as solvent. (auth)

17441 ELECTRODEPOSITION OF RUTHENIUM. Mason, David Roy; Lerwill, Brian R. (to Engelhard Industries Ltd.). U. S. Patent 3,625,840. 7 Dec 1971. Filed 19 Jan 1970.

A stable, aqueous electrolyte solution, suitable for use in the electrodeposition of ruthenium, was developed. The aqueous solution has a pH in the range 1.2 to 3.0 and contains ruthenium ions complexed by an organic acid, sulfamate ions, and ammonium ions. (auth)

17442 EXTRACTION OF MIXED COMPLEX COMPOUNDS OF THE URANYL ION WITH THENOYLTRIFLUOROACETONE AND ORGANIC COMPOUNDS. Kononenko, L. I.; Burtnenko, L. M.; Vitkun, R. A. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 574-8(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 556-62(Jul-Aug 1971).

A study was made of the extraction by benzene of mixed complex compounds of the uranyl ion with thenoyltrifluoroacetone and antipyrine or 1,10-phenanthroline, with the formula $MeTTA_2B$. A possible mechanism of the extraction of compounds of this type is discussed. Formulas were derived relating the distribution coefficient E of the uranyl ion to the concentrations of the ligands and hydrogen ions. The values of E as a function of the pH of the solution, concentration of anions of the ligand and base in the aqueous phase, as well as the concentrations of the electronegative ligand and base in the organic phase were found experimentally and agree with the equations derived. The constants of the extraction of complex compounds were determined. (auth)

17443 EXTRACTION OF COMPLEX ACIDS BY OXYGEN-CONTAINING SOLVENTS. XVI. MECHANISM OF THE EXTRACTION OF TELLURIUM. Iofa, B. Z.; Ridvan, M. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 556-8(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 534-8(Jul-Aug 1971).

It was established that tellurium(IV) is extracted by alcohols (possibly by ketones and esters as well) from solutions of hydrohalic acids in the form of hydrated and solvated complex acids $H_2(H_2O)_mS_n$ $TeHal_6$. Octanol extracts tellurium(IV) from 2.7 M HCl in the form of $H_2(H_2O)_mS_2TeCl_6$, from 2.4 to 4.9 M HBr in the form of $H_2(H_2O)_mS_2TeBr_6$, and from 1.0 to 2.9 M HI in the form of $H_2(H_2O)_mS_3TeI_6$. (auth)

17444 KINETICS OF ION EXCHANGE OF THE RARE EARTH ELEMENTS OF NaX ZEOLITE. Brezhneva, N. E.; Dement'ev, V. D.; Kapshaninov, Yu. I.; Popov, I. V. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 547-51(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 525-30(Jul-Aug* 1971).

The kinetics of ion exchange of rare earths (La^{3+}, Ce^{3+}, Pr^{3+}, Nd^{3+}, and Sm^{3+}) on synthetic NaX zeolite was investigated. Under the experimental conditions, the step determining the ion exchange process is diffusion of ions within the ion exchanger, while the diffusion coefficients for each ion are constant up to a degree of exchange of the order of 50%. The activation energies of diffusion were found, and it was shown that there is no dehydration of the cations in the process of ion exchange. The activation energies and coefficient D_0 for the diffusion of the Pm^{3+} ion into NaX zeolite were found by a comparative method. (auth)

17445 ANTAGONISTIC EFFECT IN THE SYSTEM HNO_3–Mo(VI)–D2EHPA–TBP AND THE MECHANISM OF THE EXTRACTION OF MOLYBDENUM(VI) BY D2EHPA FROM STRONGLY ACID SOLUTIONS. Bykhovtsov, V. L. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 677-8(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 657-8(Jul-Aug 1971).

Experimental data are presented on the distribution of molybdenum(VI) in the system HNO_3–Mo(VI)–DEHPA–TBP–kerosene. The experiments were conducted at a ratio $V_\phi/V_{aq} = 1$, temperature 20 ± 2°C, and time of contact of the phase 5 min. Tributyl phosphate has an antagonistic effect on the extraction of molybdenum(VI) by DEHPA from solutions of nitric acid. The antagonistic effect on the system is intensified with increasing C_{TBP} and increasing acidity of the aqueous phase. The distribution coefficient of molybdenum(VI) in the system is practically independent of the nitrate ion concentration in the aqueous phase. (M.C.G.)

17446 SYNTHESIS AND IR, X-RAY, AND ION-EXCHANGE STUDIES OF SOME AMORPHOUS AND SEMICRYSTALLINE

PHASES OF TITANIUM ANTIMONATE. SEPARATION OF VO^{2+} FROM VARIOUS METAL IONS. Qureshi, Mohsin; Kumar, Virendra (Aligarh Muslim Univ., India). J. Chromatogr.; 62: No. 3, 431-8(25 Nov 1971).

Amorphous and semicrystalline samples of titanium antimonate were synthesized by mixing solutions of titanium(IV) chloride and antimony pentachloride of different concentrations in various volume ratios at a constant pH of zero. The selectivities for 27 metal ions, including Sr, Sc, Y, Zr, La, Ce, Pr, Nd, Sm, Th, and UO_2^{2+}, of four chemically different samples were compared. Infrared spectra and d values for titanium antimonates were compared with those reported for antimonic acid and sodium antimonate. (auth)

17447 SYNERGISTIC EFFECT IN THE SOLVENT EXTRACTION OF EUROPIUM AND ZINC BENZOYLTRIFLUOROACETONATE ADDUCTS WITH PHOSPHINE AND ARSINE OXIDES. Aoki, Toru; Deguchi, Etsuo; Matsui, Masakazu; Shigematsu, Tsunenobu (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 5, 307-13(Sep 1971).

The influence of organic Lewis base on the solvent extraction of europium and zinc benzoyltrifluoroacetonates was studied. Triphenylarsine oxide (TPAsO), triphenylphosphine oxide (TPPO), tri-n-octylphosphine oxide (TOPO), methylenebis(diphenylphosphine oxide) (MBDPO) and ethylenebis(diphenylphosphine oxide) (EBDPO) were employed for the neutral ligand. Reacting with europium chelate, dioxide ligands form the adducts of MR_3L type, but monooxide ligands make the adducts of MR_3L_2 type. The stability constant of the monooxide adducts increases in the following order: TPPO < TPAsO ≃ TOPO. The influence of the neutral ligand on the synergistic effect in the zinc chelate system increases in the following sequence: TPPO < EBDPO < MBDPO < TOPO. (auth)

17448 BEHAVIOR OF CERTAIN RADIOISOTOPES OF THE RARE EARTH ELEMENTS IN THEIR REDUCTION ON A LIQUID CATHODE OF WOOD'S METAL. Shvedov, V. P.; Stepanov, V. I. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 626-8(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 610-13(Jul-Aug 1971).

The optimum conditions for the deposition of cerium and praseodymium on a liquid cathode of Wood's metal were found. The possibility of using a Wood's metal cathode for the separation of cerium, praseodymium, and europium, is suggested. It is suggested that the electrochemical isolation of cerium has at least two steps: reduction of the alkali metal with the formation of an intermetallic compound with the elements contained in Wood's metal and replacement of the alkali metal by a rare earth metal in the intermetallic compound. (auth)

17449 THERMODYNAMIC EQUILIBRIUM CONSTANTS AND THERMAL EFFECTS OF THE REACTIONS OF EXTRACTION OF URANYL NITRATE BY DIALKYL PHOSPHATES IN INERT SOLVENTS. IV. TRI-n-AMYL PHOSPHATE (TAP). Pushlenkov, M. F.; Komarov, E. V.; Shpunt, L. B. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 654-6(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 637-9(Jul-Aug 1971).

The structure of the solvate $UO_2(NO_3)_2 \cdot 2TAP$ (TAP = triamyl phosphate) was established. The thermodynamic equilibrium constants of the extraction of uranyl nitrate by solutions of TAP in carbon tetrachloride and n-decane at the temperatures 10 to 50°C were determined. The thermodynamic functions of the extraction reaction were determined according to the temperature dependence of the equilibrium constant. (auth)

17450 THERMODYNAMIC EQUILIBRIUM CONSTANTS AND THERMAL EFFECTS OF THE EXTRACTION OF URANYL NITRATE BY TRIALKYL PHOSPHATES IN INERT SOLVENTS. V. TRI-n-HEXYL PHOSPHATE (THxP). Komarov, E. V.; Shpunt, L. B.; Pushlenkov, M. F. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 657-8(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 639-41(Jul-Aug 1971).

The structure of the solvate $UO_2(NO_3)_2 \cdot 2THxP$ (THxP = trihexyl phosphate) was established. The thermodynamic equilibrium constants of the extraction of uranyl nitrate by solutions of THxP in carbon tetrachloride and n-decane were determined. The thermodynamic functions of the extraction reaction ΔH, ΔG, and ΔS, at t = 25°C, were determined from the dependence of the equilibrium constant on the temperature. (auth)

17451 PAPER THERMOCHROMATOGRAPHY. XV. INFLUENCE OF THE TEMPERATURE RANGE PRODUCING THE TEMPERATURE GRADIENT ON THE SEPARATION OF THE MIXTURES $Ni^{2+} + Mn^{2+}$, $Ce^{3+} + La^{3+}$, AND $Hf^{4+} + ZrO^{2+}$. Gocan, S.; Hodisan, T.; Liteanu, Margareta; Liteanu, C. Stud. Univ. Babes-Bolyai, Ser. Chem.; 16: No. 1, 37-41(1971). (In Rumanian).

It is shown that, in addition to the temperature gradient, the position of the range producing this gradient can also constitute a source for differentiation in the migration of mixtures of substances on an open column. (tr-auth)

17452 STUDY OF THE SORPTION OF URANIUM ON CARBONATE FORMS OF ANION EXCHANGERS. Eristavi, D. I.; Eristavi, V. D.; Kutsiava, N. A. Soobshch. Akad. Nauk Gruz. SSR; 65: No. 1, 57-60(Jan 1972). (In Georgian).

The sorption of uranium under dynamic conditions on carbonate forms of anion exchangers has been studied. The mechanism of sorption is explained with the aid of ir spectral and roentgenographic analysis. The optimal conditions of sorption have been determined and the prospectiveness of the use of the studied anions in extracting uranium from analyzed solutions has been ascertained. (auth)

17453 EXTRACTION OF SODIUM, CESIUM, AND CALCIUM BY THE PHENOLS OF VARIOUS STRUCTURES. Gindin, L. M.; Fleitlikh, I. Yu.; Khol'kin, A. I.; (and others) (Inst. of Inorganic Chemistry, Moscow. Inst. of Chemical Kinetics and Combustion, 'Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 14, Ser. Khim. Nauk; No. 6, 72-8(Nov 1970). (In Russian).

The extraction of sodium, cesium, and calcium by various phenols was studied. The influence of the substituents and the solvent nature on extraction equilibria was demonstrated. The influence of the overall metal concentration on extraction equilibria in the case of the dissociation of extractable complexes in the organic phase was studied by the example of the sodium extraction by solutions of thyme camphor in isoamyl alcohol. (auth)

17454 EXTRACTION OF URANIUM(IV) BY DI-(2-ETHYLHEXYL)-PHOSPHORIC ACID FROM AQUEOUS NITRIC ACID SOLUTIONS. Schmid, E. R.; Pfannhauser, W. (Univ., Vienna). Atomkernenergie; 19: No. 1, 53-7(Feb 1972). (In German).

The distribution of uranium(IV) between aqueous nitric acid solutions and bis (2-ethylhexyl) phosphate (DEHPA) in different organic solvents was studied. The influence of nitric acid and nitrate molarity in the aqueous phase and the DEHPA concentration and the kind of diluent in the organic phase was investigated. At low nitric acid concentrations (<2 m) uranium is extracted via an ion exchange mechanism and at high acid concentrations (>4 m) it is extracted via a solvate mechanism. The better the diluent solvates the DEHPA the lower is the uranium distribution ratio. Some additional results of the uranium(VI) distribution in the same system are also reported. (auth)

17455 CONTRIBUTIONS TO THE CHEMISTRY OF RARE ELEMENTS. LXXI. SEPARATION OF SCANDIUM FROM YTTRIUM USING MONOCHLOROACETIC ACID AND SULFURIC ACID SOLUTIONS. Petru, F.; Pesek, J. (Technische Hochschule fuer Chemie, Prague). Collect. Czech. Chem. Commun.; 36: No. 11, 3752-64(Nov 1971). (In German).

The elution of Sc^{3+}, Y^{3+}, and La^{3+} from a column of the strongly acid cation exchanger Dowex 50WX4 by solutions of a series of organic and inorganic acids was studied at various values of pH. Conditions were found for the separation of Sc from Y and La by eluting with 1 M monochloroacetic acid partially neutralized with NH_4OH, or with 0.5 M H_2SO_4. The preparation of spectrally pure Sc_2O_3 from the eluate is described. (tr-auth)

17456 DISTRIBUTION STUDIES OF METAL-8-QUINOLINOL CHELATES IN A NONAQUEOUS SYSTEM. Spigarelli, J.; Meloan, C. E. (Kansas State Univ., Manhattan). Separ. Sci.; 7: No. 1, 85-95(1972).

The influence of water on the distribution of several metal-8-quinolinol chelates between nitromethane and 1-decanol was studied. These observations were utilized to describe the general equilibria involved in extraction processes. The distribution ratios (nitromethane/1-decanol) of bis(8-quinolinolo)dioxouranium (VI)-8-quinolinol, bis(8-quinolinolo)dioxouranium(VI), tris(8-quinolinolo)iron(III), and bis(8-quinolinolo)zinc(II) in dry solvents were determined by visible and atomic absorption spectrophotometry to be 0.95, 0.92, 1.90 and 0.11, respectively. The extraction into the 1-decanol phase increased with the number of unfilled coordination sites of the metal, indicating that the extractions were proceeding by solvation of the metal chelates. The influence of water was attributed primarily to hydrolysis of the chelates in nitromethane, and the magnitude of this effect was correlated to

the respective metal chelate formation constants. The chelates were found to be resistant to hydrolysis in 1-decanol. (auth)

17457 LEACHING IN-SITU: A NEW MINING METHOD. Abou-Zeid, Aly M. New York; Columbia Univ. (1970). 153p. University Microfilms Order No. 71-23,575.

Thesis.

Leaching in-situ is a new technique proposed to be a successful new mining method. Six experiments were conducted using uranium-bearing sandstone and uniaxial flow of 0.2N solution of sulfuric acid and satisfactory recovery ranging from 59.5 to 76.1% was achieved. The relationships between percentage recovery and permeability, between uranium concentration in leach liquor and permeability and between gas and liquid permeabilities were established. The experiments did not reveal any conclusive relationship between the percentage recovery and the uranium assay in the rock and that between average uranium concentration in leach liquor and the initial uranium assay in the rock. (Diss. Abstr. Int., B)

17458 RECOVERY OF URANIUM VALUES FROM ORES. LeFrancois, R.; Gautier, R. (to Ugine Kuhlmann). Canadian Patent 880,813. 14 Sep 1971. Priority date 8 Mar 1968, France.

Uranium is leached from uraniferous ores in which U is mainly present in the form of autenite and compounds dispersed in a gangue having a base of $Ca_3(PO_4)_2$ and silica. The process is carried out by circulating the finely divided ore in several reactor vessels successively and maintaining the ore in the vessels in contact with an aqueous solution of SO_2 at 15 to 30°C. The process avoids high heat energy consumption and is applicable to the direct treatment of an ore which is extracted from the mineral deposit in the form of sludge of fairly thick consistency. Roasting at high temperature is thus avoided and only low power consumption is required. (F.S.A.) (Canada)

17459 EXTRACTION OF EUROPIUM WITH DI(2-ETHYLHEXYL)PHOSPHORIC ACID. EQUILIBRIUM OF Eu EXTRACTION IN THE HIGHER CONCENTRATION REGION OF Eu PART. Shiokawa, Jiro; Matsumoto, Akira; Takatsuji, Kuzuhiko; Hirashima, Yoshiyuki (Osaka Univ., Suita, Japan). Denki Kagaku; 39: No. 10, 831-4(Oct 1971). (In Japanese).

Equilibrium of Eu extraction was studied in the system of aqueous solutions of $EuCl_3$ (0.01 to 1.00 mole/l) and a solution of 1.0 mole/l of D2EHPA in n-heptane. At higher concentrations of Eu, the distribution coefficient of Eu decreased with an increase in the initial concentration of HCl and total rare earths, which was virtually the same as at lower concentrations of Eu. At concentrations higher than 0.5 mole/l, the quantity of Eu extracted in the organic phase and the increase of the acidity in the aqueous phase were nearly constant, and both values changed with the initial concentration of HCl and decreased linearly with the increase in the concentration of HCl in the aqueous phase. The ratio of the latter to the former, i.e., $(\Delta[H^+]_{aq}/[Eu]_{org})$ was 2.6 to 2.8, which was smaller than that at lower concentrations of Eu. It was deduced that the equilibrium and mechanism of Eu extraction at higher concentrations are different from those at lower concentrations. (auth) (Japan)

17460 RECENT ADVANCES IN LIQUID–LIQUID EXTRACTION. Hanson, C. (ed.). Elmsford, N. Y.; Pergamon Publishing Company (1971). 598p. $23.00.

A review is presented of developments in the science and practice of liquid–liquid extraction that have taken place during the last decade. The areas considered are: the current position of solvent extraction; the chemistry of solvent extraction; industrial inorganic processes; industrial organic processes; industrial contacting equipment; response, characteristics, and control of extraction processes; calculation of contactors with longitudinal mixing; the study of longitudinal mixing in liquid–liquid contactors; interfacial phenomena; mass transfer to drops; simultaneous heat and mass transfer; mass transfer with simultaneous chemical reaction; heat transfer by direct liquid–liquid contact; and coalescence of liquid droplets and liquid dispersion. (D.H.M.)

17461 SEPARATION OF TRACE METALS FROM MOLYBDENUM AND TUNGSTEN BY MEANS OF A CHELATE-FORMING ION EXCHANGER. Steinbach, Siegfried; Hering, Rudolf. Z. Chem.; 11: No. 9, 350-1(Sep 1971). (In German).

Two types of ion exchange resins proved successful in removing trace elements from tungstate and molybdate solutions. Ten liters of ammonium molybdate or tungstate solution were prepared from 1.5 kg MoO_3 or WO_3, respectively. At room temperature, the solution flowed with a rate of 1 cm/min through the exchange column. The filtrate was evaporated. After heating, the WO_3 and MoO_3 samples were studied spectroanalytically. Results showed that the procedure reduces all trace metals below the detection level, with the exception of Si, Co, Na, and K. Efficiency of the ion exchange column depended on quantity of trace elements, temperature, and pH. (H.B.G.)

17462 ISOLATION AND PURIFICATION OF AMERICIUM FROM OTHER 5f AND 4f ELEMENTS BY EXTRACTION CHROMATOGRAPHY. Moore, Fletcher L. (to United States Atomic Energy Commission). U. S. Patent 3,615,268. 26 Oct 1971. Filed 29 Nov 1968.

A method for selectively removing americium values from an aqueous solution containing americium as well as other 5f and/or 4f elements comprises selectively oxidizing the americium to the +5 oxidation state and then passing the resultant solution through a stationary phase or static bed of an inert material having impregnated on its surface a diester of orthophosphoric acid such as di(2-ethylhexyl)phosphoric acid. (Offic. Gaz.)

17463 SEPARATION OF NEPTUNIUM FROM URANIUM HEXAFLUORIDE CONTAINING THE SAME. Golliher, Waldo R.; Harris, Robert L.; LeDoux, Reynold A. (to United States Atomic Energy Commission). U. S. Patent 3,615,267. 26 Oct 1971. Filed 11 Mar 1969.

A method of selectively removing neptunium values from a gaseous mixture containing neptunium hexafluoride and uranium hexafluoride comprises passing the mixture through a bed of pelletized cobaltous fluoride at a temperature in the range 220 to 440°F to reduce neptunium to a nonvolatile form that remains in the pelletized bed. The neptunium can be removed from the bed by passing fluorine gas through the bed at a temperature of 500 to 700°F. (Offic. Gaz.)

17464 SEPARATION OF RARE EARTHS BY ELECTROLYSIS WITH POROUS CARBON ELECTRODES. Onstott, Edward I. (to United States Atomic Energy Commission). U. S. Patent 3,616,326. 26 Oct 1971. Filed 22 Oct 1969.

A method is described for separating europium from trivalent rare earth elements by passing an electrolyte containing a mixture of such elements between porous carbon electrodes at a cell potential of 2 to 2.5 volts. As the mixture of cations passes through the porous cathode, Eu(III) is selectively reduced to Eu(II), which can then be precipitated as $EuSO_4$. (Offic. Gaz.)

17465 ION EXCHANGE BEHAVIORS OF INORGANIC IONS IN ION EXCHANGE RESINS OF DIAION SKN-1 AND SAN-1. DISTRIBUTION RATIOS OF IONS IN THE SYSTEM OF DIAION–HYDROCHLORIC ACID. Yokotsuka, Seiichiro (Mitsubishi Chemical Industry Co., Ltd., Yokohama, Japan); Akatsu, Eiko; Ueno, Kaoru. J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 622-9(Nov 1971).

The distribution ratios of 42 inorganic ions were radiochemically determined in a system of Diaion SKN-1 in H-form and 0 to 4 M hydrochloric acid, and in another system of Diaion SAN-1 in Cl-form and 1 to 9M hydrochloric acid. The results are presented in an arrangement that follows the sequence of the periodic table. Several data were also obtained on Amberlite IRN-77 and -78 for comparison. (auth)

17466 EXTRACTION OF TITANIUM AND RARE METALS BY HYDROCHLORIC ACID SOLUTION FROM THE HYDROLYSIS PRODUCTS FROM TITANIUM PRODUCTION WASTES. Sorokin, I. P.; Vasilenko, V. P.; Tsarinnaya, A. V. Sb. Tr., Vses. Nauch.-Issled. Proekt. Inst. Titana; No. 5, 99-105(1970). (In Russian).

Results are given from tests on the leaching of Ti, Ta, Nb, and Zr by HCl solution from wet concentrates obtained by the hydrolysis of spent furnace melts. A typical composition is TiO_2 39.0, Nb_2O_5 2.87, Ta_2O_5 0.299, and ZrO_2 7.9%. The optimum treatment conditions were: treatment with 15 to 20% HCl, solid : liquid = 1 : 4, temperature 80 to 100°C, for 30 min, with continuous agitation. A single stage extraction of a freshly deposited wet concentrate gave extractions into the acid of Ti ≤ 75, Zr ≤ 99, Nb ≤ 84, and Ta ≤ 66%. (Referativnyi Zh.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 18180.

17467 (IS–2600) CERAMIC ENGINEERING, CHEMICAL ENGINEERING, CHEMISTRY, MATHEMATICS AND COMPUTER SCIENCE, METALLURGY, PHYSICS, AND REACTOR DIVISIONS ANNUAL SUMMARY RESEARCH REPORT, JULY 1970–JUNE 1971. (Ames Lab., Iowa). Dec 1971. Contract W-7405-eng-82. 312p. Dep. NTIS.

Separate abstracts were prepared for five of the seven sections presented. (D.H.M.)

For abstracts of individual sections see: 17331, 17468, 18118, 18271, and 18802

17468 (IS–2600, pp 9-23) CHEMICAL ENGINEERING DIVISION. (Ames Lab., Iowa). Dec 1971.

In Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1970–June 1971.

Research progress is reported on extraction chemistry, liquid metal studies, and materials preparation and characterization: single crystals. (D.H.M.)

Chemical and Physical-Chemical Properties

Refer also to abstracts 17456, 17574, 17585, 17586, 17598, 17599, 17610, 17640, 18122, 18127, and 19621.

17469 (ORNL-tr–2561) MODIFICATION OF POLYURETHANE COMPOUNDS BASED ON CASTOR OIL AND DIISOCYANATES FOR USE IN HIGH-VOLTAGE TERMINALS IN RADIATION TECHNOLOGY. Chubukov, V. N.; Miroshin, N. F.; Ermakova, T. I. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Radiats. Tekh.; No. 6, 204-9(1971). 4p. Dep. NTIS.

Compounds KG-102 and KT-102, based on castor oil and diisocyanate, were modified to improve their lifetimes without worsening the physicomechanical and dielectric properties. Properties of the new compounds, KT-102M, KT-102, and KG-102 were determined. (M.C.G.)

17470 MECHANISM OF HYDROGEN REDUCTION OF URANIUM HEXAFLUORIDE. Tumanov, Yu. N.; Galkin, N. P. At. Energ. (USSR); 32: No. 1, 21-5(Jan 1972). (In Russian).

The reduction of uranium hexafluoride with hydrogen, usually described as an exothermic reaction, $(UF_6)_{gas} + (H_2)_{gas} = (UF_6)_{solid} + 2(HF)_{gas} - 69.8$ kCal, is, in reality, a complex process, consisting of two steps (in the first approximation): exothermic – $(UF_6)_{gas} + (H_2)_{gas} = (UF_4)_{gas} + 2(HF)_{gas} + 7.47$ kCal, and, endothermic – $(UF_4)_{gas} = (UF_4)_{gas} - 73.1$ kCal. The high thermodynamic stability of the molecules H_2 and UF_6 up to 1400°K eliminates a noticeable contribution of the dissociation in the mechanism of the reduction. It seems that the primary part of this process is the endothermic reaction of the formation of the monoradicals on the scheme: $(UF_5 - F)_{gas} + (H - H)_{gas} = (UF_5)_{gas} + (HF)_{gas} + (H)_{gas} + 49.62$ kCal. This primary part is accompanied by the gaseous exothermic reactions: $(UF_5)_{gas} + (H)_{gas} = (UF_4)_{gas} + (HF)_{gas} - 54.58$ kCal, and $(UF_6)_{gas} + (H)_{gas} = (UF_5)_{gas} + (HF)_{gas} - 42.15$ kCal. Above 1400°K the role of the dissociation of the molecules UF_6 increases. The activation energy of the supposed primary process is equal to 49.6 kCal/mole UF_6. This value is more than the experimental activation energy of 10 kCal/mole UF_6. This fact indicates the complex character of the interaction of the different elementary chemical processes in the condensation of UF_4 and of the heterogeneous interaction of the condensed phase and the uranium hexafluoride. (auth)

17471 FORMATION OF PRECIPITATES OF EUROPIUM HYDROXIDE. Grebenshchikova, V. I.; Davydov, Yu. P.; Pershin, A. S. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 542-6(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 521-5(Jul-Aug 1971).

It was shown that at a europium concentration in solution $\sim 10^{-3}$ M, the formation of europium hydroxide precipitate occurs bypassing the step of formation of a continuous chain of polymers. (auth)

17472 INVESTIGATION OF THE COMPLEX FORMATION OF TRIVALENT ACTINIDE AND LANTHANIDE ELEMENTS BY THE METHOD OF ELECTROMIGRATION. IX. INSTRUMENTS AND METHOD OF DETERMINING ION MOBILITY IN THE MEDIUM OF A POROUS FILLER. Stepanov, A. V.; Shalinets, A. B. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 662-4 (Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 644-6(Jul-Aug 1971).

Two variations of a research apparatus for electromigration in a powdered filler are suggested. The electrode chambers and system of circulation, construction materials, and methods of determining mobilities are described. (M.C.G.)

17473 LANTHANUM TRIFLUORIDE AS A MEMBRANE IN A REFERENCE ELECTRODE FOR USE IN CERTAIN MOLTEN FLUORIDES. Bronstein, H. R.; Manning, D. L. (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc.; 119: No. 2, 125-8(Feb 1972).

A reference electrode system that utilizes the unique properties of a single crystal lanthanum trifluoride membrane, namely, negligible solubility and virtually 100% current transport by fluoride ions, was successfully used both for electroanalytical measurements and for obtaining thermodynamic data in certain fluoride melts of interest to the Molten Salt Breeder Reactor. (auth)

17474 CORRELATION BETWEEN THE VIBRONIC SPECTRA OF THE URANYL ION AND THE GEOMETRY OF ITS COORDINATION. Goerller-Walrand, C.; De Jaegere, S. (Univ., Louvain, Belg.). Spectrochim. Acta, Part A; 28: No. 2, 257-60(Feb 1972).

Absorption spectra of some thirty uranyl complexes were registered. Solid compounds were studied at 77°K for good spectral resolution. The same complexes were examined in solution at room temperature to determine extinction coefficients for all the maxima of the spectra observed. Three experimental criteria, which are described in detail, are used to distinguish between the various overlapping electronic transitions which compose the observed spectra. Features as positions and intensity, vibrational progressions and intensity distribution of vibrational bands are established for the majority of the electronic transitions suggested. From the discussion of these features it is concluded that the geometry of coordination of the ligands around uranyl and not the nature of the ligands determines frequencies and intensities of the spectral transitions in uranyl compounds. In conclusion attention is drawn on the importance of ligand field effects in any theoretical model, which until now have very often been neglected in favor of the axial field of the linear uranyl ion. (auth)

17475 STANDARD FREE ENERGIES FOR THE FORMATION OF FLUORIDES IN SEVERAL METALS BY ELECTROMOTIVE FORCE MEASUREMENTS. Tanaka, Hiroshi; Yamaguchi, Akio; Moriyama, Joichiro (Kyoto Univ.). J. Jap. Inst. Metals; 35: No. 12, 1161-4(Dec 1971). (In Japanese).

The standard free energies for formation of AlF_3, ThF_4, UF_3, UF_4, CrF_2, MnF_2, and CrF_3 were determined by emf measurements from fluorine concentration cells operated at 600°C. From the emf values and $\Delta^fG^0(MgF_2)$ obtained from Δ^fH^0 data by calorimetry measurements, the standard free energies of formation of the above fluorides at 600°C were calculated as follows: $\Delta^fG^0(AlF_3) = -306.0 \pm 0.2$, $\Delta^fG^0(ThF_4) = -436.6 \pm 0.8$, $\Delta^fG^0(UF_3) = -310.9 \pm 0.8$, $\Delta^fG^0(UF_4) = -394.0 \pm 1.3$, $\Delta^fG^0(CrF_2) = -156.4 \pm 0.3$, $\Delta^fG^0(MnF_2) = -175.0 \pm 0.2$, $\Delta^fG^0(CrF_3) = -229.1 \pm 1.0$, (kcal/mole). (auth)

Isotope Effects

17476 (COO–1617-30) KINETIC ENERGY ISOTOPES EFFECT IN THE REACTIONS OF (n,γ)-ACTIVATED ^{128}I AND ^{130}I WITH CH_4, CD_4, AND HALOMETHANES. Yoong, M.; Pao, Y. C.; Rack, E. P. (Nebraska Univ., Lincoln. Dept. of Chemistry). [1971]. Contract AT(11-1)-1617. 22p. Dep. NTIS.

The kinetic energy spectra for (n,γ)-activated ^{128}I were calculated for the 2, 3, and 4 random-step processes. The results show that the recoil energy spectrum for ^{128}I is sufficiently low so that an appreciable fraction is born near or in the reactive zone $E_2 - E_1$. The kinetic-energy isotope effect in the hot reactions activated by radiative neutron capture is discussed. Two prime factors in determining the extent of reaction for (n,γ)-activated species are the kinetic-energy spectra of the hot atoms or ions and the system energy-degradation factor. (auth)

17477 (IS-T–484) MATRIX ISOLATION STUDIES OF SMALL MOLECULES. Pacansky, Jacob Jr. (Ames Lab., Iowa). Jan 1972. Contract W-7405-eng-82. 119p. Dep. NTIS.

Thesis.

A study is presented of the infrared matrix isolation spectra of small molecules consisting of two major sections. The infrared matrix isolation spectra of H_2S and D_2S performed under the usual assumptions of matrix isolation: (the potential field and the anharmonicity of the vibrations for the matrix isolated molecule are identical to those in the gas phase; and differences in isotopic shifts between the gas phase and the matrix are negligible) and the validity of the assumptions is examined. HCN was chosen for this task because it is well characterized spectroscopically and its geometry is simple. (auth)

17478 (KFKI–71-70) APPLICATION OF THE MINIMAX APPROXIMATION TO THE ISOTOPE EFFECT ON HEAT CAPACITY OF IDEAL GASES. Gellai, B.; Jancso, G. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 11p. Dep. NTIS (U. S. Sales Only).

The minimax approximation to the isotope effect on heat capacity

of ideal gas molecules is worked out. The rate of convergence and the utility of this approximation are discussed by means of numerical calculations for various polyatomic molecules and the results compared with those obtained by other approximations. (auth)

17479 SOLVENT DEUTERIUM ISOTOPE EFFECTS OF ACID-BASE REACTIONS. PART VI. RECALCULATION OF THE RATIO OF IONIC PRODUCTS OF LIGHT AND HEAVY WATER. Salomaa, Pentti (Turku Univ., Finland). Acta Chem. Scand.; 25: 367-8(1971).

The recalculation based on recent values for the standard free energy changes gives 7.47 ± 0.24 for $K_w(H_2O)/K_w(D_2O)$ at 25°C. Values derived from independent sets of measurements show excellent agreement. (Denmark)

17480 ISOTOPE EFFECTS ON HYDROXIDE ION IN AQUEOUS SOLUTION. Walters, E. A.; Long, F. A. (Cornell Univ., Ithaca, N. Y. Univ. of New Mexico, Albuquerque). J. Phys. Chem.; 76: No. 3, 362-5(3 Feb 1972).

A method separating primary and secondary isotope effects on hydroxide ion involved in proton abstraction reactions in mixed aqueous solutions of H_2O and D_2O is proposed. The method is based on the transfer effect formalism of the Gross–Butler theory of solvent isotope effects. A fractionation factor for hydroxide ion of 0.45 and a degenerate activity coefficient for transfer of hydroxide from H_2O and D_2O, explicitly assuming $\gamma_{H_3O^+} = 1.0$, of 1.14 are obtained from water ion product data in mixed aqueous solvents. These are applied to the rate data for detritiation of 1.4-dicyano-2-butene-1-t at 25° by the bases hydroxide and triethylamine; the observed hydroxide ion isotope effect, $k_{OH^-}^{H_2O}/k_{OH^-}^{D_2O} = 0.722$, is factored into a secondary kinetic isotope effect, $k_{OH^-}^{H_2O}/k_{OD^-}^{H_2O} = 0.57$, and a secondary solvent isotope effect, $k_{OH^-}^{H_2O}/k_{OH^-}^{D_2O} = 1.27$. The triethylamine isotope effect is totally a secondary solvent effect, $k_{Et3N}^{H_2O}/k_{Et3N}^{D_2O} = 1.24$. (auth)

17481 INFRA-RED CRYOGENIC STUDIES. PART 6. DEUTERIUM CHLORIDE IN ARGON AND OTHER MATRICES. Davies, J. B.; Hallam, H. E. (University Coll. of Swansea, Wales). Trans. Faraday Soc.; 67: No. 587, 3176-90(Nov 1971).

Infrared spectra are reported for DCl in a variety of matrices at 20°K. At low DCl concentrations, absorptions due to monomeric DCl are observed. Hindered rotation is observed in three matrices that offer spherically symmetrical substitutional sites (Ar, Kr, SF_6) and assignments are made to the vibration-rotation lines including R(2) and P(2). The rotational spacing for DCl decreases less from gas to matrix than for HCl as predicted by a rotational-translational coupling model. Rotation is not observed in matrices offering cylindrical substitutional sites (N_2, CO_2, CO) or in CH_4. Matrix-induced frequency shifts show a similar behavior to those of HCl. A detailed study was made of the association of DCl in argon matrices and the two dominant multimer bands that arise are assigned to cyclic dimer and cyclic trimer. Further bands assigned to higher multimers agree well with predictions from an intermolecular resonance interaction model, though detailed study of HCl–DCl mixed multimers in argon shows that this model is only fully successful in dealing with trimers and higher multimers. Spectra of binary mixtures of DCl/X in Ar (X = N_2, CO_2, and CO) show three groups of induced bands arising from DCl–X, $(DCl)_2$–X and DCl–X–DCl interactions. With N_2 and CO_2 the interactions are thought to be largely electrostatic but CO has a much stronger effect suggesting a specific hydrogen-bond interaction involving the oxygen atom. (auth)

17482 DEUTERIUM EFFECTS ON SINGLET OXYGEN LIFETIMES IN SOLUTIONS. A NEW TEST OF SINGLET OXYGEN REACTIONS. Merkel, Paul B.; Nilsson, Robert; Kearns, David R. (Univ. of California, Riverside). J. Amer. Chem. Soc.; 94: No. 3, 1030-1(9 Feb 1972).

The development of a simple diagnostic test for singlet oxygen reactions is reported based on the large deuterium effects on the lifetime of singlet oxygen. The method does not require addition of foreign components to a solvent (as in the azide or β-carotene quenching) which might react with excited dye or singlet oxygen, nor is there any change in most properties of the solvent. (D.H.M.)

17483 POLARIZATION DIFFERENCES BETWEEN ISOTOPIC MOLECULES. Halevi, E. A. (Technion-Israel Inst. of Tech., Haifa). Int. J. Quant. Chem., Symp.; No. 5, 367-70(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

A brief report on the determination of dipole moment differences by a differential dielectric constant method is presented. The results are sufficiently precise to be compared with the corresponding differences obtained with modern spectroscopic techniques. It is shown that the two sets of results are concordant if—and only if—Van Vleck's equation for electric polarization is used. Application was made to perdeuteroammonia vs ammonia and deuterium chloride vs hydrogen chloride. (auth)

17484 DEUTERIUM ISOTOPE EFFECTS ON ^{13}C CHEMICAL SHIFTS IN BENZENE AND SUBSTITUTED BENZENES. Bell, R. A.; Chan, C. L.; Sayer, B. G. (McMaster Univ., Hamilton, Ont.). J. Chem. Soc., D; No. 2, 67-8(19 Jan 1972).

The ^{13}C NMR isotope shifts induced by deuterium in monosubstituted benzenes were found to be dependent upon vibronic and polar factors. The observed, directly bonded shifts for deuterium in the ortho position are suggested as a measure of a Hammett σ_0. (auth)

17485 ANOMALOUS BEHAVIOR OF ^{18}O-LABELED COMPOUNDS. VI. THE VIBRATIONAL SPECTRA OF ISOTOPIC METABORATES. Pinchas, S. (Weizmann Inst. of Science, Rehovoth, Israel); Shamir, J. J. Chem. Phys.; 56: No. 5, 2017-9(1 Mar 1972).

The infrared absorption spectrum of an aqueous solution of ^{18}O-labeled sodium metaborate shows the antisymmetric $B-{}^{18}O$ stretching ν_3 fundamental of its $B(OH)_4^-$ ions at 982 cm^{-1}, as compared with the frequency of 958 cm^{-1} observed for the respective normal borate vibration. The Raman spectrum of aqueous solutions of these borates exhibits their symmetric B–O stretching ν_1 fundamental in both cases at 744 cm^{-1}. The fact that the ν_1 and ν_3 frequencies of the hydrated $B(^{18}OH)_4^-$ ions are not decreased by the $^{16}O-{}^{18}O$ exchange is taken to indicate that the hydrogen bonding between the $B(OH)_4^-$ ions and their solvating water molecules is appreciably lower in the case of the ^{18}O-labeled ions than in the case of the $B(^{16}OH)_4^-$ ions. (auth)

Isotope Exchange and Isotope Separation

17486 (MLM–1891) OXYGEN ISOTOPE EXCHANGE OF $^{238}PuO_2$. Miles, J. C.; Deaton, R. L.; Wiedenheft, C. J. (Mound Lab., Miamisburg, Ohio). 25 Feb 1972. Contract AT(33-1)-Gen-53. 22p. Dep. NTIS.

Powder, particles, and pellets of $^{238}PuO_2$ undergo oxygen isotope exchange to form $^{238}Pu^{16}O_2$. Solid-solution ThO_2-PuO_2 also undergoes oxygen exchange to yield a fuel form with a low neutron flux. The experimental conditions that give best exchange results involve exchange and sintering at or above 1400°C. The rate data show that to completely exchange particles of PuO_2 in a period of time less than 1 hr temperatures in excess of 1300°C will be required. Pellets sintered near 1600°C for several hours also exchange very slowly due to the presence of a diffusion-controlled reaction. The oxygen exchange of $^{238}PuO_2$ using a flowing gas system is also described. (auth)

17487 ELUTION STUDIES ON THE ADSORPTION SYSTEM NICKEL–HYDROGEN, DEUTERIUM. Wedler, G.; Santelmann, G. (Univ., Erlangen, Ger.). Ber. Bunsenges. Phys. Chem.; 75: No. 10, 1026-32(Oct 1971). (In German).

Nickel films with thicknesses of about 100 Å and known crystallographic properties are produced by evaporation and annealing under uhv conditions. They are covered by hydrogen or deuterium to different extents. It is tried to replace hydrogen by deuterium or deterium by hydrogen at 77°, 150°, 195°, and 273°K by means of a discontinuously performed exchange. The replacement is complete at 273°K and 195°K, but at 150°K it takes place only to an extent of 80%, and at 77°K only to 3%. It can be shown that the whole adsorbed phase takes part in the equilibrium with the gas phase at 273°K and 195°K. At 77°K the whole chemisorbed phase and at 150°K 20% of the chemisorbed phase do not take part in this equilibrium. This shows that there must be at least two different states of adsorbed hydrogen, but they are not identical with the two states that can be deduced from the desorption spectra. An a-priori-heterogeneity seems to be responsible for the existence of the latter states. (auth)

17488 INTERACTION OF HYDROGEN WITH A NICKEL(110) SURFACE. Ertl, G.; Kueppers, D. (Technische Univ., Hanover). Ber. Bunsenges. Phys. Chem.; 75: No. 10, 1017-25(Oct 1971). (In German).

The interaction between hydrogen and a clean Ni(110) surface was investigated using contact potential measurements, flash desorption, LEED, and mass spectrometry. Adsorption takes place in an α-state ordered in one dimension and with an adsorption heat of 19.5 kcal/mole, which is almost independent on the coverage. This α-state transforms slowly into a β-state with an increase in the binding energy of 10 kcal/mole to give a two dimensional order (1 · 2-structure). The kinetics of the adsorption and

desorption processes have been studied in detail using a relaxation method by measuring changes of the work function. The H_2/D_2 exchange reaction is very fast at room temperature and is determined by the Eley–Rideal mechanism. The transition from the α- to the β-state causes a decrease in the rate of reaction. (auth)

17489 MECHANISM OF DEUTERIUM EXCHANGE WITH NEOPENTANE; STUDIES IN THE FIELD ION MASS SPECTROMETER. Hindennach, P.; Block, J. (Max-Planck-Gesellschaft, Berlin). Ber. Bunsenges. Phys. Chem.; 75: No. 10, 993-8 (Oct 1971). (In German).

In a field ion mass spectrometer the deuterium exchange with neopentane is investigated on Pd surfaces at a gas pressure of 10^{-5} to 3 Torr (deuterium surplus) and at temperatures between 298° and 550°K. The product distribution (1 to 12 deuterium) shall prove the mechanism (single or multiple exchange during a single adsorption step) and indicate the chemisorption structure of neopentane. The Pd-field emitter (a) a Pd surface (b) surrounding the field emitter (Pt) or an effusion cell with high surface area Pd (c) are used as catalysts. During the reaction molecules can only perform a few (a) or an average of 10^3 impacts (b) or can be brought to unlimited exchange (c). The results prove the single exchange during an adsorption step, although diffusion influences in (c) do conceal expected binomial distributions. Collision efficiencies (not measurable in (a), 10^{-6} in (b) and 10^{-10} in (c)) and experimental activation energies (≈3 kcal/mole in (b) and 31 kcal/mole in (c)) are quite diversified. Different collision efficiencies and activation energies (apparent and true) can be explained by the thermodynamic properties of the adsorption state. (auth)

17490 HYDROGEN ISOTOPE EXCHANGE IN THE STUDY OF PROTEIN CONFORMATION. A QUANTITATIVE TEST OF AN EXCHANGE MECHANISM. Willumsen, Lars. Compt. Rend. Trav. Lab. Carlsberg; 38: No. 14, 223-95(1971).

Various techniques for measuring hydrogen isotope exchange in protein are discussed and compared. A number of extensive studies on various proteins are reviewed. The results are tested graphically and show agreement with the limiting case of the exchange mechanism. In those instances where deviations apparently occur, there appear to exist plausible reasons for this. If exchange data for different proteins and for poly-D,L-alanine are introduced in the same plot, it is possible directly to evaluate the degree of retardation of the exchange reaction for peptide hydrogens at various levels and to compare the retardation of corresponding peptide hydrogens in different proteins. In accordance with the exchange mechanism, the average retardation of the exchange of the peptide hydrogens in a protein equals the average standard free energy for the transconformational reactions, which freely expose the peptide hydrogens in the protein to the aqueous solvent. Some 16 proteins are ranked according to increasing magnitude of average standard free energy. This order cannot be accounted for by considerations of the molecular size and shape alone. It undoubtedly reflects the intramolecular forces which vary markedly from protein to protein. (auth)

17491 INVESTIGATION OF THE KINETICS OF CRYSTALLIZATION AND ISOTOPIC EXCHANGE OF FERRIC NITRATE. Babayan, S. G.; Isakhanyan, S. S.; Medvedeva, L. P. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 528-31(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 505-8(Jul-Aug 1971).

The kinetics of crystallization of saturation solutions of $Fe(NO_3)_3$ was investigated. At the stage of intensive nucleation, the formation of metastable intermediate product of variable composition with a fluctuating character was observed. In an investigation of isotopic exchange between crystals of $Fe(NO_3)_3 \cdot$ (6 to 9)H_2O and the saturated solution, it was shown that after a certain time interval has elapsed, there is a displacement of the equilibrium in the direction of the formation of $Fe(NO_3)_3 \cdot 6H_2O$ by a transfer of three water molecules of the nonahydrate crystal hydrate to the saturated solution. (auth)

17492 INVESTIGATION OF THE KINETICS OF CRYSTALLIZATION AND ISOTOPIC EXCHANGE OF DISUBSTITUTED SODIUM PHOSPHATE. Babayan, S. G.; Isakhanyan, S. S.; Medvedeva, L. P. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 522-7(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 499-505(Jul-Aug 1971).

The kinetics of the crystallization of disubstituted sodium phosphate was investigated. In the process of crystallization, at the stage of intensive nucleation, the formation of an intermediate unstable compound of variable composition is observed. The ability of the solid phase, isolated at various moments of crystallization, for isotopic exchange was investigated. It was shown that the quasiperiodic fluctuations in the system can be explained by assuming a dominant significance of the water of the saturated solution in heterogeneous processes. Kinetics of isotope exchange between crystals and saturated solutions were computed. (auth)

17493 REACTION OF HYDROGEN CYANIDE AND DEUTERIUM BEHIND REFLECTED SHOCK WAVES. Brupbacher, J. M.; Kern, R. D. (Louisiana State Univ., New Orleans). J. Phys. Chem.; 76: No. 3, 285-91(3 Feb 1972).

A complementary shock tube technique was employed to study the exchange reaction occurring in equimolar mixtures of HCN and D_2 over the temperature range 2000 to 3000°K. One shock tube of the complementary system recorded infrared emission from HCN and DCN highly dilute in argon. The second shock tube was coupled to a time-of-flight mass spectrometer in order to monitor mass peaks of interest at 20 μsec intervals. The experiments spanned a total gas density variation of 1.8×10^{-6} to 4.3×10^{-6} mole/cm^3. Typical observation periods were about 500 μsec during which time an equilibrium condition was established for the higher temperature runs. Agreement of the results from the two independent techniques was obtained within one standard deviation. The data from both shock tubes were fit to an expression involving mole fractions, $\{1 - f_{DCN}[1 + (f_{HCN}/f_{DCN})_{eq}]\} = \exp(-k[HCN][M]^{0.52}t^2)$, with the rate constant given by $k = 10^{22.21 \pm 0.19} \exp(-51{,}540 \pm 2080/RT)$, cm^3 mole^{-1} sec^{-2} (M)$^{-0.52}$. On a concentration basis, the reaction was found to be second order with respect to reactants and 0.52 with respect to the total density. No attempt was made to determine the individual orders with respect to HCN and D_2. The formation of DCN was found to be a nonlinear function of time which clearly indicates that the mechanism for the exchange is complex. (auth)

17494 SELECTION RULES FOR CHEMICAL REACTIONS USING THE ORBITAL PHASE CONTINUITY PRINCIPLE. Goddard III, William A. (California Inst. of Tech., Pasadena). J. Amer. Chem. Soc.; 94: No. 3, 793-807(9 Feb 1972).

Some recent ab initio calculations on simple molecular reactions are examined and found to indicate that in order for a reaction to have a low-activation energy certain phase relationships must occur between the orbitals of the reactants and the orbitals of the products. Herein this simple principle is developed and applied to several reactions of conjugated and nonconjugated molecules. For thermal reactions, the resulting selection rules are in general agreement with the generalized Woodward–Hoffmann rules [some exceptions occur for reactions involving open-shell molecules, e.g., $O_2(^1\Delta_g)$ and $NH(^1\Delta)$] and with experiment. However, the orbital phase continuity principle (OPCP) does not depend upon molecular symmetry and hence can be applied easily to reactions involving no symmetry. The OPCP is based on the generalized valence bond (GVB) self-consistent field method, which leads to orbitals more akin to the valence bond description than to the Hartree–Fock or molecular orbital description. Thus, in a sense the use of OPCP for selection rules for chemical reactions might be considered the valence-bond analog of the Hoffmann–Woodward approach (for MO wave functions). (auth)

17495 ISOTOPE EXCHANGE VS ABSTRACTION FOR H + DCl. Wood, Gerry Odell (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 56: No. 4, 1723-7(15 Feb 1972).

Rates of isotope exchange reactions in deuterium chloride–hydrogen mixtures photolyzed at 1849 Å were measured by mass spectroscopy. Under conditions where reactions of product molecules were negligible quantum yields of HD and D_2 were calculated using DCl for actinometry. Large HD quantum yields indicate that chain reactions occur. The ratio of HD to D_2 formed in these chain reactions is shown to be equal to the ratio k_2/k_3 of rate coefficients for the abstraction (2), H + DCl → HD + Cl, and the exchange (3), H + DCl → HCl + D. From quantum yields at 27–225°C this ratio is calculated to be $k_2/k_3 = (850 \pm 200) \exp[-(2220 \pm 180)/RT]$. A quantum yield of D_2 independent of chain lengths and with little temperature dependence is attributed to the reaction D* + DCl → D_2 + Cl of hot atoms from DCl photodissociation. (auth)

17496 HYDROGEN–DEUTERIUM EQUILIBRATION REACTION CATALYSED BY GRAPHITE–POTASSIUM COMPOUNDS. Watanabe, Kazuo; Kondow, Tamotsu; Soma, Mitsuyuki; Onishi, Takaharu; Tamaru, Kenzi (Tokyo Univ.). J. Chem. Soc., D; No. 2, 39-40(19 Jan 1972).

The activity pattern of the series of graphite–potassium compounds for the H_2-D_2 equilibration reaction was found to be $C_{24}K > C_{36}K \geq C_8K$-hydride $\gg C_8K \sim 0$. (auth)

17497 THEORY OF ISOTOPIC EXCHANGE BY THE MECHANISM OF ELECTRON TRANSFER. I. ONE STEP OF ELECTRON TRANSFER. Plonski, I. H. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 8, 875-83 (1971).

The theory of isotopic exchange between metals and their ions in solution is developed, considering that the electron transfer in one step is the rate-determining reaction. It is shown that the time constant of the process depends on the ratio between the quantity of metal and of ions in solution, as follows: it increases when this ratio decreases, passes through a maximum value when this ratio reaches 1, then decreases toward zero. From the maximum time constant and the corresponding ion concentration, it is possible to determine the exchange current density. (auth)

17498 THEORY OF ISOTOPIC EXCHANGE BY THE MECHANISM OF ELECTRON TRANSFER. II. TWO-STEP ELECTRON TRANSFER. Plonski, I. H. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 9, 989-98(1971).

The theory of isotopic exchange between metals and their ions in solution is developed, considering that the electron transfer proceeding in two steps is the rate-determining reaction. It is shown that the time constant τ of the process depends on the quantities of metal as well as of the quantities of intermediate ions and of the final ions involved in the exchange process and also on the value of the ratio between the exchange currents corresponding to the two steps. For $i_{01} \ll i_{02}$, τ increases with increasing final ion concentration $[M^{2+}]_e$, with a slope d log τ/d log $[M^{2+}]_e = 3/4$, passes through a maximum value, then decreases with a slope d log τ/d log $[M^{2+}]_e = -1/4$; for $i_{01} \gg i_{02}$, τ increases with increasing $[M^{2+}]_e$ with a slope d log τ/d log $[M^{2+}]_e = 1/4$, passes through the maximum value, then decreases with a slope d log τ/d log $[M^{2+}]_e = -3/4$. (auth)

17499 THERMODYNAMICS OF HYDROGEN-ISOTOPE-EXCHANGE REACTIONS. I. ELECTROCHEMISTRY IN DIMETHYLFORMAMIDE. Silvester, Leonard F.; Kim, Janice J.; Rock, Peter A. (Univ. of California, Davis). Contract AT(04-3)-34 P.A. 169. J. Chem. Phys.; 56: No. 5, 1863-9(1 Mar 1972).

Results for the direct experimental determination of the equilibrium constants for the hydrogen-isotope-exchange reaction, $D_2(g) + 2HCl(DMF) = H_2(g) + 2DCl(DMF)$, where DMF is the solvent N, N-dimethylformamide, are reported. The reaction was studied in electrochemical double cells without liquid junction of the type, $(Pt)D_2(g) \mid DCl(DMF) \mid TlCl(s) \mid Tl(Hg) \mid TlCl(s) \mid HCl(DMF) \mid H_2(g)(Pt)$. The experimentally determined values of $\epsilon^0(296.6°K)$ for this cell are $\epsilon^0_{ion} = 7.64 \pm 0.38$ mV and $\epsilon^0_{neut} = 8.12 \pm 0.54$ mV, where ϵ^0_{ion} refers to strong electrolyte standard states for HCl(DMF) and DCl(DMF), and ϵ^0_{neut} refers to undissociated solute standard states for HCl(DMF) and DCl(DMF). The corresponding experimental values of the equilibrium constants are $K_{ion} = 1.82 \pm 0.05$ and $K_{neut} = 1.89 \pm 0.08$ (296.6°K). The experimental values of the equilibrium constants are compared with values for K calculated from statistical thermodynamic theory for model reactions. (auth)

17500 THERMODYNAMICS OF LITHIUM ISOTOPE EXCHANGE REACTIONS. II. ELECTROCHEMICAL INVESTIGATIONS IN DIGLYME AND PROPYLENE CARBONATE. Singh, Gulzar; Hall, John C.; Rock, Peter A. (Univ. of California, Davis). Contract AT(04-3)-34 P.A. 169. J. Chem. Phys.; 56: No. 5, 1855-62(1 Mar 1972).

Final results for the direct experimental determination of the equilibrium constants for the lithium isotope exchange reactions $^7Li(s) + {}^6LiBr(digl) = {}^6Li(s) + {}^7LiBr(digl)$ (1) and $^7Li(s) + {}^6Li^+(PC) = {}^6Li(s) + {}^7Li^+(PC)$ (2) involving the solvents diglyme (digl, $\epsilon = 7.2$) and propylene carbonate (PC, $\epsilon = 65.5$) are reported. These reactions were studied in electrochemical double cells without liquid junction. The experimentally determined values of the equilibrium constants at 296.6°K are $K_1 = 1.035 \pm 0.007$ and $K_2 = 1.030 \pm 0.005$. The experimental values of K_1 and K_2 are compared with values calculated from statistical thermodynamic theory for various model reactions. A Born–von Kármán lattice calculation was carried out for the isotopic lithium metals. (auth)

17501 INVESTIGATION OF ISOTOPIC EFFECTS OF CALCIUM IN HETEROGENEOUS EXCHANGE EQUILIBRIA. Heumann, Klaus Gustav; Lieser, Karl Heinrich (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch.; 27b: No. 2, 126-33(Feb 1972). (In German).

The following heterogeneous exchange equilibria were examined for isotopic effects: $CaCO_3/Ca^{2\oplus}_{aq.}$, Ca-GBHA/$Ca^{2\oplus}_{aq.}$ and $Ca^{2\oplus}_{Dowex\ 50}$/$Ca^{2\oplus}_{aq.}$ (GBHA = glyoxal-bis(2-hydroxyanul)). The isotopic ratios $^{44}Ca/^{40}Ca$ and $^{48}Ca/^{40}Ca$ were determined by means of a mass spectrometer with a thermal ions source. In the system $CaCO_3/Ca^{2\oplus}_{aq.}$ the elementary separation factor was found to be less than 1% or 0.5% per mass unit, respectively. For the exchange in the system Ca-GBHA/$Ca^{2\oplus}_{aq.}$ in the concentration range from 0.011 to 0.84M an elementary separation factor less than 1‰ per mass unit was found; from a three-stage experiment at a calcium concentration of 1.23 M it was concluded that the elementary isotopic effect is less than 0.4‰ per mass unit. Therefore no isotopic fractionation is expected for precipitation of inorganic or organic calcium salts. An enrichment of the heavier calcium isotopes in the solution was found in the case of the exchange in a Dowex 50-X12 loaded column. The isotopic effect depends on the concentration of the hydrochloric acid used as the eluent. (auth)

Feed Materials Processing

Refer also to abstracts 17596 and 17597.

Radiation Chemistry

Refer also to abstracts 17923 and 19595.

17502 (ANL–7856) APPLICATIONS OF THE VAN SLYKE MANOMETRIC APPARATUS TO RADIATION CHEMISTRY. Hart, Edwin J.; Thomas, J. K. (Argonne National Lab., Ill.). Sep 1971. Contract W-31-109-eng-38. 29p. Dep. NTIS.

Detailed instructions and illustrations are given for the estimation of dissolved gases in irradiated aqueous solutions by the Van Slyke manometric apparatus. This versatile instrument makes possible the analysis of a wide variety of samples, such as evacuated, air-free, and gas-containing irradiated solutions. The gases in the sample are equilibrated with the liquid in the Van Slyke pipette under definite pressure, volume, and temperature conditions. The evolved gases are separately determined either by absorbents, or by a calibrated gas chromatograph. From these measurements, the concentration of the dissolved gas can be readily calculated by Van Slyke factors recorded in a table for volumes in the 5.00 to 25.00 range. The Argonne radiation-chemistry techniques of sample preparation in evacuated cells and syringes and the methods of evacuation and gas equilibration are also described. (auth)

17503 (ANL–Trans–908) STIMULATED EMISSIONS OF THE FIRST AND SECOND POSITIVE SYSTEMS OF N_2 PRODUCED BY PULSE RADIOLYSIS. Clerc, Michel; Schmidt, Michel. Translated for Argonne National Lab., Ill., from Compt. Rend. Ser. B; 272: No. 11, 668-71(15 Mar 1971). 5p. Dep. NTIS.

The use of brief electron pulses of 560 keV (3-ns duration) produced by an accelerator results in population inversions in the electron transitions with very short radiative lifetimes. Thus, stimulated light emissions were observed in the first and second positive systems of nitrogen. (auth)

17504 (ORO–3519-11) RADIATION CHEMISTRY OF MONO-SUBSTITUTED AROMATIC COMPOUNDS. Progress Report, January 15, 1971–January 15, 1972. Knight, J. A. Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-3519. 8p. Dep. NTIS.

Research progress is reported on the radiolysis of benzonitrile. Hydrogen has a G ~ 0.01 and hydrogen cyanide G ~ 0.007. From the gas chromatographic analysis of the irradiated samples, there is good evidence for the three isomeric dicyanobenzenes and 4-cyanobiphenyl as radiolytic products, but no G values have been determined for these products. (D.H.M.)

17505 RADIATION CHEMISTRY OF DITHIONATES. Murthy, G. S.; Eager, R. L.; McCallum, K. J. (Univ. of Saskatchewan, Saskatoon). Can. J. Chem.; 49: No. 22, 3733-8(15 Nov 1971).

The salts $Na_2S_2O_6$, $Na_2S_2O_6 \cdot 2H_2O$, $K_2S_2O_6$, BaS_2O_6, and $BaS_2O_6 \cdot 2H_2O$ were irradiated at room temperature with ^{60}Co gamma rays. When the irradiated salts were dissolved in water sulfite ions, sulfate ions, and acid were found as irradiation products. The dependence of yield upon absorbed dose was studied. The G-values found ranged from unity to 20. Thermal annealing of the irradiated salts had only a slight effect on product yields. For BaS_2O_6 there is a large increase in product yields after a dose of 28.3×10^{22} eV per mole has been absorbed. A mechanism involving SO_3^- and $S_2O_6^-$ radical ions is proposed. (auth)

17506 LUMINESCENCE EFFECTS OF γ-IRRADIATED SILICA GEL ON SORPTION OF GASES. Rabe, J. G.; Breitkreutz, K. Ber. Bunsenges. Phys. Chem.; 75: No. 10, 1123-5 (Oct 1971). (In German).

Trapped electrons and holes, which have been produced in silica gel by γ-irradiation, interact with gas molecules adsorbed on the surface. Radiothermoluminescence (RTL), radiosorption luminescence (RSL, a light flash produced during the adsorption of gas on irradiated silica gel), and changes of the EPR-spectrum were studied. RSL is produced by recombination of trapped charges, which have been liberated by the gas adsorption, and by charge transfer from adsorbed molecules to holes. EPR measurements indicate the preferential interaction of hydrogen with holes and oxygen with electron centers. (auth)

17507 SINGLE CRYSTAL ELECTRON SPIN RESONANCE SPECTRA OF X-IRRADIATED POTASSIUM HYDROGEN MALONATE. Nicklin, Robert C. (Appalachian State Univ., Boone, N. C.); Farach, Horacio A.; Poole, Charles P. Jr. J. Chem. Phys.; 56: No. 3, 1279-83(1 Feb 1972).

Single crystals of x-irradiated potassium hydrogen malonate were studied by electron spin resonance. The principal radical produced by the irradiation was (COOH) (·CH) (COOK). The main hyperfine doublet arose from the coupling to the α hydrogen, and satellite lines from four more distant extramolecular protons were identified. Previous theory on the positions and intensities of satellite lines was extended to include the present case. A model was prepared for the arrangement of the molecules in the unit cell. (auth)

17508 MOESSBAUER STUDY OF IRRADIATED IRON CHELATES AND CHEMICAL CONSEQUENCES OF ^{57}Co ELECTRON CAPTURE IN COMPLEX LIGAND COMPOUNDS. Baggio-Saitovitch, E.; Friedt, J. M.; Danon, J. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). J. Chem. Phys.; 56: No. 3, 1269-74(1 Feb 1972).

The Moessbauer absorption spectra of Fe(III) acetylacetonate, Fe(III) citrate Fe(III) EDTA, and Fe(III) trisdipyridyl perchlorate irradiated with electrons at liquid nitrogen temperature are found to be similar to the emission spectra after electron capture of ^{57}Co in analogous Co(III) compounds. This result suggests that an autoradiolysis mechanism is responsible for the stabilization of the anomalous iron charge states in these compounds. The main effect of the radiolysis is found to be the reduction of the trivalent iron complex to the corresponding bivalent one. A mechanism involving the formation and fast annihilation of free radicals is invoked for explaining the radiation reduction process. (auth)

17509 EPOXY ADDUCTS FOR RADIATION-CURABLE COATINGS. Labana, S. S.; Aronoff, E. J. (Ford Motor Co., Dearborn, Mich.). J. Paint Technol.; 43: No. 560, 77-80(Sep 1971).

Epon 828 (diglycidyl ether of 4,4′-isopropylidenediphenol) can be converted to radiation-polymerizable divinyl compounds by reacting with methacrylic or acrylic acids. Further reaction of these derivatives with unsaturated acid chlorides produces tetravinyl compounds which are also radiation-sensitive. On irradiation with an electron beam, divinyl and tetravinyl adducts of diepoxides polymerize rapidly to hard films. These films, however, contain a substantial amount of unpolymerized double bonds due to a limiting conversion reached in the polymerization process. The extent of limiting conversion depends on the functionality of the adduct, presence of solvents, presence of monomers, and glass transition temperature (T_g) of the film formed. For complete conversion of unsaturation, a minimum amount of vinyl monomer must be added to divinyl or tetravinyl compounds. Electron-beam irradiation of blends of these epoxy adducts with a low-T_g, unsaturated acrylic polymer and vinyl monomers results in completely cured coatings with excellent hardness, flexibility, and adhesion to steel. (auth)

17510 GRAFT COPOLYMERIZATION OF STYRENE AND LIGNIN. II. KRAFT SOFTWOOD LIGNIN. Phillips, R. B.; Brown, W.; Stannett, V. T. (North Carolina State Univ., Raleigh). J. Appl. Polym. Sci.; 16: No. 1, 1-14(Jan 1972).

The γ-radioinduced graft copolymerization of styrene and various kraft softwood lignins was studied. Expression of the results as the usual "per cent graft" was impossible, because grafting caused the lignin to become extractable in solvents for the styrene homopolymer. However, evaluation of the effects of various solvents on the degree of reaction was made through an indirect, and possibly more characteristic, measure. Grafting was least pronounced under conditions of low lignin accessibility (e.g., when less than 10% methanol was present), but increased with the addition of better lignin solvents or with higher methanol concentrations. The precipitating nature of the latter conditions was also found to contribute to an accelerated rate of grafting. Surprisingly, the graft copolymer was found to degrade at higher doses. Proof of grafting is offered in a fractionation scheme. Measurement of the molecular weight of the polystyrene separated from the lignin backbone allows the estimation of approximately one polystyrene graft per lignin molecule in benzene-extractable copolymers. Two glass transition temperatures could be detected in several fractionated copolymers. (auth)

17511 POLYMER STRUCTURE FORMED IN RADIATION-INDUCED GRAFT POLYMERIZATION. Matsuzaki, Kei; Kanai, Taiichi; Morita, Nobuyuki (Tokyo Univ.). J. Appl. Polym. Sci.; 16: No. 1, 15-20(Jan 1972).

Methacrylic acid (MAA) and methyl methacrylate (MMA) were grafted onto nylon 6, cellulose triacetate, cotton, viscose rayon, and polyester fibers, and the stereoregularities of the grafted polymers were determined. The graft polymerization was carried out with preirradiation techniques using γ rays from a ^{60}Co source. The grafted copolymers were then separated from the homopolymers by Soxhlet extraction. The grafted (branch) polymers were isolated from the trunk polymers by acid hydrolysis and their stereoregularity was determined with a 100-MHz NMR spectrometer. The stereoregularity of PMAA or PMMA grafted onto viscose rayon or cotton fiber was different from that of the polymers formed in ordinary radical polymerization. (auth)

17512 COLOR STABILIZATION OF POLY(VINYL CHLORIDE) AGAINST HIGH-ENERGY ELECTRON IRRADIATION. Albarino, R. V.; Otocka, E. P. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Polym. Sci.; 16: No. 1, 61-8 (Jan 1972).

Color stability in irradiated poly(vinyl chloride), PVC, may be achieved by structural modification to block dehydrochlorination, addition of radiation protectors, or addition of radical scavengers. This study explores the latter approaches. Twenty-six compounds representing a variety of structural types were screened for their effectiveness as measured by subsequent color development. Fifteen of the compounds imparted partial or complete postirradiation stability. Possible stabilizer mechanisms are discussed. (auth)

17513 LEAD COMPOUNDS USED TO PROMOTE ATOMIC RADIATION INDUCED CROSS-LINKING IN CHLORINATED OLEFIN POLYMERS. Ryffel, James R. (to Dow Chemical Co.). U. S. Patent 3,627,658. 14 Dec 1971. Filed 9 Jan 1970.

A method is presented for radioinduced crosslinking of chlorinated olefin polymers and sheet materials that involves the addition of one to ten parts by weight of a lead compound. (D.H.M.)

17514 CHLOROBROMINATION OF BENZENE IN THE PRESENCE OF HIGH ENERGY RADIATION. Harmer, David E. (to Dow Chemical Co.). U. S. Patent 3,616,379. 26 Oct 1971. Filed 11 Jan 1968.

Chlorobromination of benzene to produce principally 1-chloro-2,3,4,5,6-pentabromocyclohexane is accomplished by a process comprising contacting chlorine, bromine, and benzene in the presence of high-energy radiation. (auth)

17515 RADIATION TREATMENT OF HALOGEN CONTAINING OLEFINICALLY UNSATURATED ESTERS. Marx, Matthias; Zosel, Albrecht; Spoor, Herbert; Pohlemann, Heinz; Heinze, Dieter (to Badische Anilin- and Soda-Fabrik Aktiengesellschaft). U. S. Patent 3,627,659. 14 Dec 1971. Priority date 11 Jul 1967, Germany.

A process is presented for the production of coatings, impregnations or bonds by polymerization and cross-linking of mixtures containing olefinically unsaturated esters containing halogen by means of ionizing radiation. (auth)

17516 THERMAL AND RADIATION STABILITY OF PEROXYDISULFATE IONS IN AQUEOUS SOLUTIONS. Ermakov, V. A.; Timofeev, G. A.; Rykov, A. G.; Yakovlev, G. N.; Deikalov, V. K. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 629-32 (Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 614-18(Jul-Aug 1971).

The thermal decomposition of peroxydisulfate ions was found to be a first-order reaction with respect to concentration in water, nitric acid, and carbonate solutions. An activation energy of 25 kcal/mole was found. The rates of decomposition of $S_2O_8^{2-}$ ions in the presence of an internal α emitter (^{242}Cm) were measured in water and nitric acid at specific α activities of solutions of 280 and 1650 Ci/liter. The decomposition proceeds according to a first-order reaction with respect to concentration. The rate of thermal decomposition of $S_2O_8^{2-}$ ions in water at 18°C was negligible in comparison with the rate of their decomposition in the presence of α radiation, while at temperatures above 70°C, radiation chemical decomposition can be neglected. The radiation chemical yield was practically unchanged with increasing absorbed dose and increased somewhat when the nitric acid concentration in the solution was increased. (M.C.G.)

17517 γ-IRRADIATION OF VERBENONE AND VERBENOL. Tsankova, Elena; Kulesza, Janusz; Gora, Jozef (Polytechnical Univ., Lodz, Poland). Rocz. Chem.; 45: No. 10, 1791-2(1971).

Samples of verbenone were γ irradiated at 10 to 500 Mrad and the products identified by ir spectrography and gas–liquid chromatography. Only those samples receiving doses of 220 Mrad and above showed the presence of chrysanthenone. The behavior of

cis- and trans-verbenol on irradiation with γ rays was investigated. At 220 Mrad, no change was observed in trans-verbenol, but colorless crystals of cis-verbenol turned into a thick oil and the ir spectra showed OH-group bands. (M.C.G.)

17518 ELECTRON PARAMAGNETIC RESONANCE OF ELECTRON-IRRADIATED $K_2Rh(CN)_6$ IN KCl LATTICE. Muniz, R. P. A.; Vugman, N. V.; Danon, J. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fiz., Cent. Brasil. Pesqui. Fis.; 16: No. 13, 181-97(1970).

Electron irradiation of the diamagnetic $Rh(CN)_6^{3-}$ ion in a KCl host lattice produces three paramagnetic species. EPR studies reveals that one of the species can be assigned as $Rh(CN)_4Cl_2^{4-}$, of D_{4h} symmetry, $4d^7$ low-spin configuration, arising from the trapping of an electron in a d_z^2 orbital followed by the substitution of two axial cyanides by chloride ions. The experimental data were interpreted in terms of a spin Hamiltonian yielding the principal values of the g and hyperfine tensors as $g_{\parallel} = 1.995$, $g_{\perp} = 2.297$, $A_{\parallel}^{Rh} = -40.8 \times 10^{-4}$ cm^{-1}, $A_{\perp}^{Rh} = -36.9 \times 10^{-4}$ cm^{-1}, $A_{\parallel}^{Cl} = +27.8 \times 10^{-4}$ cm^{-1}, $A_{\perp}^{Cl} = +12.4 \times 10^{-4}$ cm^{-1}. Theoretical estimates of g values confirms this assignment. A semi-empirical estimate of the unpaired electron density on the metal and ligands is presented. (auth)

17519 ALTERATION OF CATALYST SURFACE COMPOSITION INDUCED BY γ-IRRADIATION. Carberry, J. J.; Kuczynski, G. C.; Martinez, E.; Susu, A. (Univ. of Notre Dame, Ind.). Nature (London) Phys. Sci.; 235: No. 55, 59(17 Jan. 1972).

In the studies reported, a Varian IEE-15 ESCA with a Mg source (K_α line) was employed to investigate whether γ-ray pre-irradiation altered the chemical composition of a supported commercial Ag catalyst, used in the oxidation of ethylene to ethylene oxide, CO_2, and H_2O. Irradiation was conducted in air at 10^{18} eV/min/g for 10 hr in a ^{60}Co source. It was found that the principal surface species (Ag) were unaffected by the irradiation, but whereas Ca did not appear on the surface of the unirradiated sample, the sample contained surface Ca after irradiation. Reduction in H_2 for 1 hr at 280°C, followed by cooling in air, gave a surface apparently free of Ca, which reappeared, however, on re-irradiation. Ca was an expected impurity in the catalyst, but the surface concentration induced by irradiation, and its reversibility, represented a novel phenomenon. Mechanisms are suggested, and its appears that γ-irradiation can cause significant changes in the chemical nature of the catalytic surface with respect to impurities, with consequent alterations in catalytic activity. The effect is profound in the case of ethylene oxidation. (UK)

17520 QUANTUM YIELDS IN THE 58.4-nm PHOTOLYSES OF AMMONIA AND WATER. Tellinghuisen, J. B.; Winkler, C. A.; Phillips, L. F. (Univ. of Canterbury, Christchurch, N. Z.). J. Phys. Chem.; 76: No. 3, 298-301(3 Feb 1972).

Quantum yields were determined by mass spectrometric analysis and by measurements of the absorption of 58.4-nm radiation by the photolysis products. At pressures where ion–electron recombination is predominantly homogeneous the quantum yields of H_2 were found to be 0.93 ± 0.15 from NH_3 and 2.1 ± 0.5 from H_2O. Yields from H_2O are sensitive to wall effects. The results are discussed in terms of known photofragmentation patterns and ion–molecule reactions, together with less well known dissociative recombination processes and neutral radical reactions. To account for the observed H_2 yield from H_2O (though not for that from NH_3) it is necessary to assume that most of the electron–ion recombination occurs by reactions of the type $H_3O^+ + e^- \rightarrow H_2 + O + H$. The relative effects of 58.4-nm ionizing photolysis and γ radiolysis are compared for H_2O, NH_3, and CO_2. (auth)

17521 MEASUREMENT OF EXCITED SINGLET YIELDS IN γ RADIOLYSIS OF BENZENE AND KETONES. THE RADIATION-INDUCED TYPE II ELIMINATION OF 4-METHYL-4-PHENYL-2-PENTANONE. Zarnegar, Bizhan M.; Whitten, David G. (Univ. of North Carolina, Chapel Hill). J. Phys. Chem.; 76: No. 2, 198-203(20 Jan 1972).

A study of the radiolytic "type II" elimination of 4-methyl-4-phenyl-2-pentanone (MPP) is reported. The γ radiolysis of MPP in benzene solution or pure ketone leads to the type II process to yield α-methylstyrene and acetone as the only major decomposition pathway. Previous photochemical studies have shown that the type II process in MPP occurs exclusively from the excited singlet state of the ketone. Quenching studies with biacetyl indicate that all of the radiolytic type II process in benzene solution and possibly 60% in pure MPP arise from the MPP excited singlet. Kinetic analysis revealed that two processes lead to production of singlet MPP in dilute (<0.1 M) benzene solutions; one is energy transfer from the benzene lowest excited singlet. A value of $G^1_{B2u} = 1.4$ is obtained from the concentration dependence of the reaction yield. The origin of the second source of MPP singlets in benzene is uncertain; one possibility is energy transfer from a higher singlet of benzene. The yield of excited singlet MPP in pure ketone is estimated to be G = 5, a value considerably higher than the singlet yield in liquid benzene. (auth)

17522 PULSED RADIOLYSIS AND FLASH PHOTOLYSIS OF IODATES IN AQUEOUS SOLUTION. Barat, F.; Gilles, L.; Hickel, B.; Lesigne, B. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. Chem.; 76: No. 3, 302-7(3 Feb 1972).

The pulsed radiolysis and flash photolysis of aqueous solutions of the iodate ion were investigated. In both cases, at neutral pH, an absorption band attributed to IO_2 is observed with a maximum at 480 to 490 nm: $\epsilon_{480}(IO_2) = 800 \pm 100$ M^{-1} cm^{-1}. This transition disappears according to a second-order process with $2k = (3.6 \pm 0.8) \times 10^9$ M^{-1} sec^{-1}. Another absorption is also observed that grows in at wavelengths less than 320 nm (band C); in the pulsed radiolysis of 0.1 M IO_3^- it decays with second-order kinetics and $2k/\epsilon_{280} = 5.7 \times 10^6$ cm sec^{-1}. Furthermore, pulsed radiolysis gives rise in neutral media to a second absorption band (band B) centered around 360 nm, formed by the reaction of OH radicals, which is assigned to IO_3. At the same wavelength in alkaline media another transient species was observed, tentatively attributed to IO_4^{2-}, whose molar extinction coefficient would be about 2600 M^{-1} cm^{-1}. (auth)

17523 OXIDATION OF AQUEOUS BROMIDE IONS BY HYDROXYL RADICALS. A PULSE RADIOLYTIC INVESTIGATION. Zehavi, Dov; Rabani, Joseph (Hebrew Univ., Jerusalem). J. Phys. Chem.; 76: No. 3, 312-19(3 Feb 1972).

Oxidation of Br^- by OH radicals in neutral and acid aqueous solutions was investigated. The reaction mechanism involves the following reactions and rate constants: $OH + Br^- \rightarrow BrOH^-$, k = $(1.06 \pm 0.08) \times 10^{10}$ M^{-1} sec^{-1}; $BrOH^- \rightarrow Br^- + OH$, k = $(3.3 \pm 0.4) \times 10^7$ sec^{-1}; $BrOH^- \rightarrow OH^-$, k = $(4.2 \pm 0.6) \times 10^6$ sec^{-1}; $BrOH^- + H^+ \rightarrow H_2O + Br$, k = $(4.4 \pm 0.8) \times 10^{10}$ M^{-1} sec^{-1}; $BrOH^- + Br^- \rightarrow OH^- + Br_2^-$, k = $(1.9 \pm 0.3) \times 10^8$ M^{-1} sec^{-1}; $Br + Br^- \rightarrow Br_2^-$, k ≃ 10^{10} M^{-1} sec^{-1} (previous work). A new absorption peak of Br_2^- at 700 nm is reported. A new equilibrium reaction of Br_2^- with Br^- to produce Br_3^{2-} is proposed. (auth)

17524 ELECTRON PARAMAGNETIC RESONANCE STUDY OF SO_2^- ON MAGNESIUM OXIDE. Schoonheydt, R. A.; Lunsford, J. H. (Texas A and M Univ., College Station). J. Phys. Chem.; 76: No. 3, 323-8(3 Feb 1972).

When SO_2 is adsorbed on thermally activated and uv-irradiated MgO, two SO_2^- species are formed. The principal values of the g-tensor are $g_{xx} = 2.0028$, $g_{yy} = 2.0097$, and $g_{zz} = 2.0052$ for SO_2^- (A) and $g_{xx} = 2.0014$, $g_{yy} = 2.0078$, and $g_{zz} = 2.0033$ for SO_2^- (B). The principal values (in gauss) for the ^{33}S tensor are $a_{xx} = 59$ and $a_{zz} = 9.4$ for $^{33}SO_2^-$ (A); $a_{xx} = 55$ and $a_{zz} = 9.4$ for $^{33}SO_2^-$ (B). The values for ^{17}O are $a_{xx} = 36$ and $a_{xx} = 29$ for SO_2^- (A) and SO_2^- (B), respectively. The odd electron, transferred from the surface of MgO to SO_2, occupies a $2b_1''$ antibonding molecular orbital and is mainly concentrated on the S atom. SO_2^- (A) is thermally more stable than SO_2^- (B), and their concentration ratio depends on the pretreatment of MgO. Both SO_2^- (A) and SO_2^- (B) are believed to be located on oxygen ion vacancies. The SO_2^- ion is probably oriented with its oxygen atoms toward the surface. The binding forces are purely electrostatic. (auth)

17525 INTERMEDIATES PRODUCED FROM THE ONE-ELECTRON OXIDATION OF HYDRAZINE. EVIDENCE FOR THE FORMATION AND DECAY OF TETRAZANE AND TRIAZENE. Hayon, E.; Simic, M. (Army Natick Labs., Mass.). J. Amer. Chem. Soc.; 94: No. 1, 42-7(12 Jan 1972).

The nature of the intermediates produced from the one-electron oxidation of hydrazine by hydroxyl radicals was studied using the technique of pulse radiolysis. The reactivity of hydrazine toward attack by OH radicals was found to be dependent on the state of protonation of the molecule: $k(OH + N_2H_5^+) = 1.0 \times 10^9$ M^{-1} sec^{-1} and $k(OH + N_2H_4) = 1.4 \times 10^{10}$ M^{-1} sec^{-1}. This reaction produces at pH 9.0 an intermediate which is assigned to the hydrazyl radical $\cdot N_2H_3$, with an absorption maximum at 230 nm (ϵ_{230} 3.5×10^3 M^{-1} cm^{-1}) and a second-order decay $2k = 2.4 \times 10^9$ M^{-1} sec^{-1}. In neutral and acidic solutions the transient absorption changes and is suggested to result from the acid-base equilibrium of the radical, $pK(\cdot N_2H_4^+ \rightleftharpoons \cdot N_2H_3 + H^+) = 7.1 \pm 0.1$. The second-order decay of the hydrazyl radical is postulated to form tetrazane, N_4H_8. A first-order formation of an intermediate with λ_{max} 225 nm (ϵ_{225} 2.8×10^3 M^{-1} cm^{-1}) and $k = 8.5 \times 10^2$ sec^{-1} at pH 9.2 is assigned to triazene, N_3H_3. Triazene and ammonia are produced from the unimolecular decomposition of tetrazane. The rate of formation of triazene is pH dependent, and the results suggest the presence of single- and double-protonated forms of tetrazane. From the change in the absorption spectrum of triazene a $pK (N_3H_4^+ \rightleftharpoons N_3H_3 + H^+) = 7.0 \pm 0.2$ was found. Triazene decays by first-order kinetics,

presumably to produce ammonia and nitrogen as required from the stoichiometry of the measured products. The decay rate is markedly dependent upon pH indicating, in part, a more rapid dissociation of the protonated form $N_2H_5^+$. Similar results were observed for 1.1- and 1.2-dimethylhydrazine. The reactivity of hydrated electrons with hydrazine and various methyl-substituted derivatives was found to be strongly dependent on both the state of protonation of the molecule and the acid strength of the hydrazines. (auth)

17526 ELECTRONIC SPECTRA, PHOTOCHEMISTRY, AND AUTOXIDATION MECHANISM OF THE SULFITE–BISULFITE–PYROSULFITE SYSTEMS. THE SO_2^-, SO_3^-, SO_4^-, AND SO_5^- RADICALS. Hayon, E.; Treinin, A.; Wilf, J. (Army Natick Labs., Mass. Hebrew Univ., Jerusalem). J. Amer. Chem. Soc.; 94: No. 1, 47-57(12 Jan 1972).

The electronic spectrum and the photochemistry of the sulfite–bisulfite–pyrosulfite systems in solution were investigated. The effects of pH, concentration, and environment upon the electronic spectrum were studied, and information was derived on some thermodynamic properties of the system and on the nature of the electronic transitions involved. Above 190 nm only HSO_3^- displays a charge-transfer-to-solvent (CTTS) band, but there is efficient ionization of the SO_3^{2-} ion on excitation within its intramolecular transition. The chain oxidation of sulfite ions in solution can lead to fast removal of oxygen from the system thus permitting the observation of the strong transient absorption of e^-_{aq} in such "air-containing" solutions. A mechanism for the autoxidation is proposed: $SO_3^{2-} + h\nu \rightarrow SO_3^- + e^-_{aq}$ ($+O_2 \rightarrow O_2^-$); $SO_3^- + O_2 \rightarrow SO_5^-$; $SO_5^- + SO_3^{2-} \rightarrow SO_4^- + SO_3^{2-}$; $SO_4^- + SO_3^{2-} \rightarrow SO_3^{2-} + SO_3^-$, and termination reactions of the radicals. Some of the species may be present in their acidic forms. This mechanism is based on results concerning the radicals SO_3^-, SO_4^-, and SO_5^-. Information on these radicals was obtained from the flash photolysis of SO_3^{2-} and $S_2O_8^{2-}$, and from the pulse radiolysis of SO_3^{2-}, $S_2O_8^{2-}$, and HSO_5^-. No direct evidence is presented for the role of SO_4^- radicals in the chain reaction, but it is inferred from the nature of the inhibition induced by alcohols (SO_3^- and SO_5^- are relatively inert to alcohols) and from the production of O_2^- in alkaline solutions. The photolysis of $S_2O_3^{2-}$ leads to the formation of SO_2^- radicals. The flash photolysis of $S_2O_8^{2-}$ has provided new information on this radical. A survey is presented on some of the properties of the oxyanions and oxyradicals of sulfur. The absorption maxima, extinction coefficients, decay kinetics, and reactivity of the radicals SO_2^-, SO_3^-, SO_4^-, and SO_5^- are included. (auth)

17527 STUDY OF THE ABSORPTION OF THE RADIATION OF THE ^{60}Co ISOTOPES BY CERTAIN PHARMACEUTICAL PRODUCTS. Velea, St.; Tamasdan, St.; Achimescu, Virginia; Danciu, Maria (Faculty of Pharmacy, Bucharest). Farmacia (Bucharest); 19: No. 6, 345-54(Jun 1971). (In Rumanian).

Acetylsalicylic acid, sodium salicylate, sulfathiazole, caffeine sodium benzoate, and phenylbutazone were exposed to a 1- to 2-μCi and a 40-mCi ^{60}Co source, in order to study the interaction of γ radiation of low and intermediate activity sources with these drugs. From the data the linear attenuation coefficients of the substances investigated were determined as a function of the radiation intensity. The high-precision data yielded by the 40-mCi source were especially helpful in determining the physicochemical properties of the materials. No radiation-induced physicochemical or pharmacodynamic changes were detected. The attentuation coefficients obtained were: sulfathiazole–0.0261; phenylbutazone–0.0145; caffeine sodium benzoate–0.0283; sodium salicylate–0.0273; aspirin–0.0160 cm^{-1}. (JPRS)

17528 REACTIONS OF TEMPERING IN SIMPLE OXYGEN-CONTAINING COMPOUNDS OF ANTIMONY IRRADIATED WITH NEUTRONS. Facetti, J. F. (Univ., Asuncion, Paraguay). Rev. Soc. Cient. Paraguay; 11: No. 1-2, 9-13(1970). (In Spanish).

The chemical consequences of neutron irradiation of ionic antimony oxides and Fe Sb_2O_4 were studied. The nature of the Sb–O bond affects the yield of SbV; the higher the yield the more covalent the bond. In addition, Fe Sb_2O_4 obeys Maddock's Rule. (auth)

17529 PREPARATION OF 1-HEPTANAMIDE USING HIGH-ENERGY IONIZING RADIATION. Marans, Nelson S.; Gush, Donald P. U. S. Patent 3,616,376. 26 Oct 1971. Filed 13 Sep 1968.

A process for preparing 1-heptanamide by irradiating a liquid system with free radical-inducing radiation in the substantial absence of oxygen is described. The liquid system is selected from the group consisting of: (1) a composition essentially of about 50 to 99.9 parts formamide, about 0 to 50 parts 1-heptanamide, and 1-hexene; and (2) a composition consisting essentially of about 50 to 99.8 parts formamide, about 0.1 to 5 parts acetone, about 0 to 45 parts 1-heptanamide, and 1-hexene, the mole ration of 1-hexene, formamide in the first liquid solution being about 1 : 300 to 2,000. The thus formed 1-heptanamide is separated and recovered. (auth)

17530 RADIATION INDUCED FORMATION OF AN IMONOXY RADICAL FROM 5-NITROURACIL. Symons, M. C. R. (Univ. of Leicester, Eng.). Mol. Phys.; 22: No. 3, 551-4(1971).

In a detailed single crystal study of 5-nitrouracil γ-irradiated at room temperature, Benson and Snipes (Mol. Phys.; 20: 357 (1971)) obtained ESR spectra of a radical having a large hyperfine coupling to a single nitrogen atom. These results are tabulated. Two alternative radicals were considered, one in which the N_1 hydrogen was removed, leaving an unpaired electron in a localized sp^2 orbital confined to nitrogen, and the other in which O_7 was lost from the nitro group. They decided in favor of the former structure, mainly because the latter was thought to be chemically improbable. The purpose of the present study was to show that the ESR data of Benson and Snipes did in fact strongly support the latter concept and ruled out the former. (UK)

17531 TUNNEL EFFECT IN ELECTRON TRANSFER REACTIONS IN THE CONDENSED PHASE. Zamaraev, K. I.; Khairutdinov, R. F.; Mikhailov, A. I.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 199: No. 3, 640-2(21 Jul 1971). (In Russian).

The velocity of reaction of electron transfer in a condensed phase usually depends on many factors such as energy, and accordingly investigation of the tunnel effect is extremely difficult. Here, the reaction kinetics of the low-temperature destruction of electrons was studied, occurring in vitrified alkali solutions during β and γ radiolysis. This rate of electron annihilation was found to be independent of the temperature between 77 and 120°K, and, apparently, down to 4.2°K. (K.S.W.)

17532 RESONATOR METHOD OF MEASURING THE DIELECTRIC PROPERTIES OF POLYMERS IN THE FIELD OF ACTION OF IONIZING RADIATION AT A FREQUENCY OF APPROXIMATELY 10^{10} Hz. Matveev, V. K.; Suchkov, Yu. D. (Leningrad Polytechnic Inst.). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 578-80(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 453-6(Apr 1971).

A resonator method of measuring the dielectric parameters of materials at a frequency of approximately 10^{10} Hz was developed. The specimen, together with the measuring cell, was situated during the measurements in the field of action of γ radiation with a dosage power of up to 500 rad/sec or in the field of action of electron radiation with a dosage power of up to 10^5 rad/sec. The dielectric constant, ϵ', and the loss tangent, tan δ, of polystyrene, polyethylene, and Teflon were measured when the specimens were irradiated with ^{60}Co. Results show that for the polymers investigated, within the limits of experimental error, the dielectric properties exhibit no reversible changes. Results are given for Teflon that was irradiated with ~1.5-MeV electrons. (D.H.M.)

17533 RADIATION INDUCED POST-COPOLYMERIZATION OF TRIOXANE WITH DIOXOLANE IN THE SOLID STATE. Sakamoto, Masahiro (Japan Atomic Energy Research Inst., Takasaki); Ito, Akihiko; Hayashi, Koichiro. Kobunshi Kagaku; 28: No. 9, 742-6(Sep 1971). (In Japanese).

Radiation-induced post-copolymerization of trioxane with dioxolane was studied. In the presence of dioxolane, the yield and molecular weight of the polymer obtained decreased with increasing dioxolane content. Thermal stability of polymer obtained increased with increasing dioxolane content and the melting point of the polymer decreased. These results show that the copolymer of trioxane–dioxolane can be obtained in this system. From kinetic study of experimental results, it was found that chain transfer reaction did not occur in this system. Using gas chromatographic analysis, it was confirmed that the dioxolane mole fraction in the copolymer was greater than that in the monomer, and the reverse reaction was found to be negligible because unreacted dioxolane could not be detected at high conversion. (auth) (Japan)

17534 RADIOCHEMICAL INCORPORATION OF NITROGEN AND SULPHUR IN ACETYLENE. Samochocka, K.; Getoff, N. (Reaktorzentrum, Seibersdorf, Austria). Int. J. Appl. Radiat. Isotop.; 23: No. 2, 65-71(Feb 1972). (In German).

By x-ray irradiation (1.8×10^{18} eV/cm^3) of the gas mixture C_2H_2–H_2S–N_2 = 1 : 1 : 1 (in the presence of 0.27% H_2, 0.95% O_2, and 1.2% acetone) at 22°C under steady-state conditions were determined: $G(H_2) = 24.4$, $G(CO) = 0.30$, $G(CO_2) = 0.90$, $G(C_2H_4) = 1.50$, $G(C_2H_6) \leq 0.1$, and $G(NH_3) = 0.1$. Furthermore, sulphur-containing compounds were obtained: G(cysteamine) = 0.1, G(cystamine) = 0.07, G(taurine) = 0.09, G(thioacetamide) = 0.2 as well as dithiooxamide ($G = 0.1$ at 23.8×10^{18} eV/cm^3). The G-values of all products are strongly dose dependent. By passing the gas mixture $C_2H_2 : N_2 = 1 : 1$ (in the presence of 0.45% H_2, 1.5% O_2, and 2% acetone) through powdered pyrite under irradiation ethylamine and two not yet identified substances could be found along with the

products mentioned above. Probable reaction mechanisms are proposed in order to explain the results. (auth)

17535 SYNTHESES OF FLUORIC RESIN BY RADIATION. Danno, Akibumi (Japan Atomic Energy Research Inst., Takasaki). Genshiryoku Kogyo; 17: No. 9, 43-9(Sep 1971). (In Japanese).

Fluoroolefins gradually polymerize when irradiated at low temperatures and give new polymers. A review was made on the features of polymerization under irradiation, polymerization of fluoroolefins under irradiation, copolymerization of fluoroolefins with olefins, and possible future developments of the irradiation polymerization technique. Thus, tetrafluoroethylene polymerizes at −196°C−90°C under irradiation. Vinylidene fluoride polymerizes at 20°C under irradiation with a high G value of 4.3×10^4. The polymerization of vinyl fluoride, which is otherwise very difficult, is easily achieved by irradiation at 20°C with a G value of 2.9×10^4. Tetrafluoroethylene copolymerizes with ethylene as well as with propylene. A 1 :1 mixture of chlorotrifluoroethylene and ethylene copolymerizes at the same molecular ratio. Copolymers obtained by irradiation often show larger tensile strength, elongation, higher melting point, and less hardness and specific gravity than those prepared by purely chemical methods. (Japan)

17536 STRUCTURE AND REACTIVITY OF ORGANIC IONS IN GAS-PHASE RADIOLYSIS. V. THE STRUCTURE AND FORMATION PROCESS OF THE $C_7H_7^+$ ION FROM TOLUENE. Yamamoto, Yukio; Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). J. Amer. Chem. Soc.; 94: No. 2, 661-3(26 Jan 1972).

The isotope distribution in the methyldiphenylmethane (MDPM) produced by the γ radiolysis of toluene-α-d_3 was determined by NMR and mass spectra in order to obtain information about the structure and formation process of the $C_7H_7^+$ ion. (D.H.M.)

17537 RADIATION EFFECTS IN POLY(VINYL ACETATE) AND ITS COPOLYMERS. Yonetani, Kaoru. Evanston, Ill.; Northwestern Univ. (1971). 113p. University Microfilms Order No. 71-30,991.

Thesis.

This investigation was motivated by an earlier study of radiation effects in poly(vinyl acetate), in which it was found that branch points are highly sensitive to radiation. Linear poly(vinyl acetate) and copolymers with trace amounts of α-methyl and β-methyl groups (0.1 to 10.0 groups per 1000 main chain carbon atoms) to simulate branching were synthesized. Radiation effects were investigated both in the pre-gel region (by light scattering) and in the post-gel region (by gel extraction). The effects of various post-irradiation treatments were studied to elucidate post-irradiation reactions, which are caused by trapped radicals. Comparisons were made between homopolymer and copolymers. Electron spin resonance spectroscopy was used to determine types, concentration, and stability on heating of these trapped radicals. UV measurements, analysis of gaseous by-products, and saponification studies on irradiated samples were also carried out. The radiation behavior of α-methyl copolymers substantiates the apparently high sensitivity toward radiation of isolated branch points, suggesting the possibility of energy transfer over long distances along the polymer chain. High sensitivity to post-irradiation oxidation was also observed in dilute α-methyl copolymer systems. (Diss. Abstr. Int., B.)

17538 PROCESS FOR COATING SURFACES WITH RESINS HAVING A POLYVINYL CHLORIDE BASE AND COATINGS OBTAINED BY MEANS OF SAID PROCESS. Blin, Marie-Francoise; Gaussens, Gilbert (to Commissariat a l'Energie Atomique). British Patent 1,256,823. 15 Dec 1971. Priority date 31 Jan 1969, France.

A process for coating surfaces comprises applying to the surface a composition composed of an ethylenically unsaturated monomer (10 to 60%) and a polyunsaturated crosslinking agent (1 to 10%) added to a vinyl chloride homopolymer or copolymer and curing the coating by exposure to ionizing radiation, preferably electrons, at a dose between 0.1 and 100 Mrad. (B.L.M.)

17539 COATING PROCESS. (to Weyerhaeuser Co.). British Patent 1,256,781. 15 Dec 1971. Priority date 15 Apr 1968, United States.

A substrate, such as wood, was coated with a flexible, impact-resistant coating by spreading a liquid coating composition over the substrate and curing the liquid coating to a flexible tack-free coating by electron irradiation. The liquid coating consists of a polyfunctional material selected from dicarboxylic acids having 4 to 15 C atoms and ester-forming derivatives of these acids, polyepoxides having reactive glycidyl groups, and dicarboxylic acid derivatives of polyepoxides mixed with a 2-hydroxyalkyl acrylate or methacrylate. The electron beam must be sufficient to impart a dose of 1 to 10 Mrad to the coating in a 1 sec or less exposure time. (B.L.M.)

17540 DEPOLYMERIZATION OF CELLULOSE ETHERS BY ELECTRON IRRADIATION. Atchison, George Jacob; Narlock, Raymond Max (to Dow Chemical Co.). British Patent 1,255,723. 1 Dec 1971. Priority date 18 Jun 1968, United States.

A process is described for the electron-induced depolymerization of alkyl cellulose ethers, which comprises irradiating a layer of a free-flowing, particulate, water-soluble cellulose ether with a beam of accelerated electrons and thoroughly blending the treated ether. The thickness of the ether layer must be uniform and must be adjusted to within 10% of the penetration depth of the electron beam for most efficient use of the electron beam energy. (B.L.M.)

17541 RADIATION-INDUCED GRAFTING OF BUTADIENE TO CHLORINATED POLYETHYLENE AND POLY(VINYL CHLORIDE). Block, Ira. College Park, Md.; Univ. of Maryland (1971). 74p. University Microfilms Order No. 72-605.

Thesis.

The radiation-induced grafting of butadiene (BD) from methanol solution to thin films of chlorinated polyethylene (PECL) and poly(vinyl chloride) (PVC) was studied as a function of chlorine content, dose rate, irradiation time, and BD concentration at room temperature. A method for determining the crystal content of chlorinated films by ir measurement is described. The results for chlorination and grafting show the least scatter when expressed in terms of weight gain per unit weight of amorphous film. This indicates that both processes take place principally in the amorphous region. The graft yield, expressed as percent graft, was found to increase with increasing weight percent of chlorine added to the amorphous fraction of the film (PCA), approaching a limiting value for grafting of BD liquid to polyethylene films with PCA greater than 45. For grafting to PECL and PVC from methanol−butadiene solutions, the graft yield was found to increase with increasing methanol concentration, reaching a maximum at from 77 to 85 vol % methanol, depending upon the PCA, and rapidly decreasing thereafter. Except for an early transient condition, the grafting rate from liquid butadiene to PVC was found to be almost independent of dose rate in the range from 3 to 300 krad/hr. However, the early graft rate is very high, and increases with increasing dose rate. The results of the investigation show that chlorination of the amorphous PE increases the glass transition temperature of the polymer, and that greatly increased graft yields are obtained when T_g is made to approach the reaction temperature. Further increase in graft yield is obtained upon dilution of the monomer by providing conditions of monomer concentration and polymer viscosity that more closely approach an optimum. The results are explained in terms of the effect of the added chlorine and the sorbed monomer on the viscosity of the swollen amorphous polymer. The effect of chlorine content on the radical yield is shown to play a small role in the enhancement of the graft yield. (Diss. Abstr. Int., B)

17542 APPROXIMATE SOLUTIONS TO THE DIFFUSION-KINETIC EQUATIONS OF RADIATION CHEMISTRY. Haskin, Floyd Eric. Manhattan, Kan.; Kansas State Univ. (1971). 132p. University Microfilms Order No. 72-1788.

Thesis.

The partial differential diffusion-kinetic equations describing the diffusion and reaction of chemically active species along the tracks of ionizing radiations are discussed. Different methods of utilizing solutions to these equations, subject to appropriate initial conditions, to predict average chemical yields are presented. The familiar prescribed-diffusion hypothesis of Samuel and Magee is examined as it applies to the few limiting cases of the diffusion-kinetic equations, which possess exact solutions. A new, less approximate separation ansatz termed prescribed axial diffusion follows logically from this examination, and the new dependent variables resulting from this ansatz are conveniently expanded in terms of certain spatially orthogonal functions. Coupled ordinary differential equations are obtained for the time-dependent expansion coefficients. A first-order truncation of one expansion form gives a general formulation of Gaussian prescribed diffusion. Higher order calculations based on an alternate expansion form are found to be rapid, internally consistent, and in good agreement with direct numerical integrations of the partial differential diffusion-kinetic equations. One of the chief advantages of the method introduced is that it allows a chain of identical overlapping spherical spurs to be treated with accuracy for multiradical reaction mechanisms. Comparison with experiment with regard to the lowering of molecular yields in water with scavenger concentration and the variation of primary product yields with LET for cyclohexane is included. (Diss. Abstr. Int., B)

17543 RADIOLYSIS OF ALKALINE ICE CONTAINING ADDITIVES. Kroh, J.; Stradowski, Cz. (Inst. of Radiation Chemistry, Lodz, Poland). Radiochem. Radioanal. Lett.; 9: No. 3, 169-77(22 Feb 1972).

The 8M glassy solutions of NaOH containing $CH_2ClCOONa$, $NaNO_3$, $NaNO_2$, and C_6H_5ONa were irradiated at 77°K with ^{60}Co γ rays in the dose range of 0.01 to 1.0 Mrad. The concentration of stabilized electrons was measured spectrophotometrically at λ_{max} = 585 nm. The influence of dose on the optical density of irradiated glasses was investigated. At high doses the concentration of stabilized electrons was found to approach a saturation level. The saturation dose and the final concentration of electrons depend on the nature of the scavenger, its concentration, and on the dose rate. The results are discussed in terms of competition between trapping and scavenging of mobile electrons and tunnelled capture of trapped electrons by adjacent scavenger molecules. (auth)

17544 APPLICATION OF ADIABATIC CALORIMETER FOR THE DETERMINATION OF CHAIN STOPPING CONSTANTS IN SOLID FORMALDEHYDE POLYMERIZATION IN γ-RADIATION FIELD AND IN POSTPOLYMERIZATION. Kiryukhin, D. P.; Kaplan, A. M.; Barkalov, I. M.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 199: No. 4, 857-60(1 Aug 1971). (In Russian).

The polymerization kinetics of solid formaldehyde in a ^{60}Co gamma radiation field were studied with the aid of an adiabatic calorimeter with a time constant of 5 to 7 sec. A similar study was also made in a bremsstrahlung beam produced by 5-MeV electrons in which the calorimeter had a time constant of only 0.3 to 0.5 sec. The liberation of heat of polymerization did not cease instantly on removal of the radiation field, but its rate subsided in time. A log rate vs 1/T graph yielded an activation energy of 1.5 ± 0.5 kcal/mole over the temperature interval 80 to 130°K. Evaluation of the chain-stopping constant required a small inertia (time lag) film calorimeter. (K.S.W.)

17545 RADIATION CHEMISTRY OF ALCOHOLS. XVI. γ-RADIOLYSIS OF MESO-ERYTHRITOL IN AQUEOUS SOLUTION. Dizdaroglu, M. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.); Scherz, H.; von Sonntag, C. Z. Naturforsch.; 27b: No. 1, 29-40(Jan 1972). (In German).

In the γ radiolysis of N_2O-saturated aqueous solutions of meso-erythritol (10^{-2} mol/l) the following products (G-values) are formed: erythrose (1) (1.3), erythrulose (2) (1.4), 2-deoxy-tetrose (3) (0.70), butanediol-(3,4)-on-(2) (4) (0.75), butanediol-(1,4)-on-(2) (5) (~0.1), glycerol aldehyde (6) (~0.1), glycol aldehyde (?) (7) (<0.1) and dimers (8) (0.45). The formation of the products can be explained by the attack of the water radicals (·OH and ·H) on the meso-erythritol to give primary meso-erythritol radicals. These radicals may disproportionate (products: 1 and 2), eliminate water, or fragment. The dimers 8 and the products 3 to 5 contain deoxy groups attached to a carbonyl function. Their precursors are meso-erythritol radicals that have split off water before dimerization or disproportionation. 6 and 7 seem to arise from β-fragmentation processes of the primary meso-erythritol radicals. (auth)

17546 CORRELATION BETWEEN MULTIPLE CHARGE-TRANSFER BANDS AND RADICAL ABSORPTION AS EXEMPLIFIED WITH PYRIDINIUM COMPOUNDS. Kosower, Edward M. (State Univ. of New York, Stony Brook); Land, E. J.; Swallow, A. J. J. Amer. Chem. Soc.; 94: No. 3, 986-7(9 Feb 1972).

Results of the absorption of pyridinyl radicals produced by the corresponding pyridinium ions with solvated electrons or COO^- radicals generated by pulse radiolysis of an oxygen-free aqueous 0.1M sodium formate – 0.01M sodium phosphate medium using 0.5 to 5-μsec pulses of 10-MeV electrons provide substantial support for the two acceptor level interpretation of pyridinium ion charge-transfer bands. (D.H.M.)

17547 PROCEEDINGS OF THE SEVENTH CELLULOSE CONFERENCE HELD AT SYRACUSE, NEW YORK, JUNE 8–11, 1971. Jahn, Edwin C. (ed.). J. Polym. Sci., Part C; No. 36, 1-546(1971). (CONF-710640).

Thirty-seven papers were presented in the following categories: oxidation and pyrolysis of cellulose; structure and behavior of cellulose and wood fibers and of wood; reactions of ammonia with cellulose and wood; physical behavior and structure of cellulose and cell wall substance; molecular organization of cellulose in the cell wall; general papers; and cellulose derivatives. An abstract was prepared for one of the papers. (D.H.M.)

For an abstract of an individual paper see: 17548.

17548 OXIDATIVE REACTIONS OF CELLULOSE INITIATED BY FREE RADICALS. Arthur, Jett C. Jr.; Hinojosa, Oscar (Dept. of Agriculture, New Orleans). J. Polym. Sci., Part C; No. 36, 53-71(1971).

From seventh cellulose conference; Syracuse, N. Y. (8 Jun 1971).

Oxidative reactions in cellulose are commonly initiated by thermal, ultraviolet, and high-energy radiations and by chemical oxidation. Long-lived free radicals, formed in cellulose on the localization of energy from thermal, ultraviolet, and high-energy radiations, and short-lived free radicals, formed in cellulose by oxidation, e.g., by ceric ion or redox reactions, were investigated by electron spin resonance spectroscopy. Dehydrogenation and oxidative depolymerization reactions of cellulose are indicated. The physical, chemical, and morphological effects of these free-radical-initiated reactions on cellulose are summarized. The formation of free radicals in cellulose also increases the chemical reactivity of cellulose, particularly for chain copolymerization reactions with vinyl monomers. Preparation of cellulose–polyvinyl copolymers, using free-radical initiation, yields paper, film, wood, and textile products with new physical and chemical properties. (auth)

17549 ISOMERIZATION PROCESSES IN IONS OF THE EMPIRICAL FORMULA $C_4H_8^+$. Lias, S. G. (National Bureau of Standards, Washington, D. C. American Univ., Washington, D. C.); Ausloos, P. J. Res. Nat. Bur. Stand.; 75A: No. 6, 591-605(Nov-Dec 1971).

Ions of the formula $C_4H_8^+$ were generated with different initial energies by ionizing ethylene ($C_2H_4^+ + C_2H_4 \rightarrow C_4H_8^+$, where the $C_4H_8^+$ ion is formed with an initial energy of >11.51 eV), cyclobutane (initial energy of $C_4H_8^+$, >10.84 eV), methylcyclopropane (>10.15 eV), 1-C_4H_8 (>9.58 eV), and i-C_4H_8 (>9.06 eV) with 11.6 – 11.8 eV photons, and in some cases also with 10 eV photons and with gamma radiation. The structures of the ions were determined from the structures of the C_4H_8 products formed in charge transfer reaction between the ions and charge acceptors such as dimethylamine and nitric oxide, as well as from the structures of the butanes formed in D_2 transfer reactions with methylcyclopentane-d_{12} ($C_4H_8^+ + C_6D_{12} \rightarrow C_4H_8D_2 + C_6D_{10}^+$). At low pressures the $C_4H_8^+$ ions initially formed in ethylene, cyclobutane, and methylcyclopropane isomerize to the thermodynamically most stable configurations, i-$C_4H_8^+$ and 2-$C_4H_8^+$. The 2-$C_4H_8^+$ structure predominates in all the experiments. As the pressure is raised, the i-$C_4H_8^+$ ion yield diminishes as that of 2-$C_4H_8^+$ increases, indicating that when the precursor of the i-$C_4H_8^+$ ion is collisionally deactivated, it ends up as 2-$C_4H_8^+$. At high pressures, 1-$C_4H_8^+$ ions are intercepted; their yield increases with increasing pressure, indicating that 1-$C_4H_8^+$ is an intermediate which isomerizes further unless it is collisionally deactivated. The 1-$C_4H_8^+$ ion formed in methylcyclopropane (initial energy >10.15 eV) is more easily deactivated than that formed in cyclobutane (initial energy >10.84 eV). That the isomerization of the 1-$C_4H_8^+$ ion to lower energy structures such as i-$C_4H_8^+$ and 2-$C_4H_8^+$ requires excess internal energy is demonstrated by the fact that in the photolysis with 10 eV photons, a negligible amount of isomerization is observed, but with 11.6 to 11.8 eV photons, more than half of the 1-$C_4H_8^+$ ions isomerize to the 2-$C_4H_8^+$ structure at a pressure of 2 torr. Isomerization of the low energy i-$C_4H_8^+$ ions formed in the photolysis of i-C_4H_8 to other structures is relatively unimportant at 11.6 to 11.8 eV. (auth)

17550 HIGH-PRESSURE RADIOLYTIC OXIDATION OF CYCLOHEXANE. Case, Forrest N.; Smiley, David E.; Kau, Donald L. (to United States Atomic Energy Commission). U. S. Patent 3,616,378. 26 Oct 1971. Filed 9 Sep 1969.

A method for the continuous conversion of cyclohexane to cyclohexanone involves a two-region cycle in a pressurized system with oxygen at a pressure in the range of 100 to 1,000 psi. In the first region of the cycle the cyclohexane is irradiated with γ radiation at a temperature of 25 to 38°C to convert a portion of the cyclohexane to cyclohexanone. The cyclohexane–cyclohexanone stream issuing from the first region is reacted with a ketone-specific reagent to remove cyclohexanone leaving the cyclohexane on stream for recycle for further irradiation until the desired degree of conversion is achieved. (B.L.M.)

17551 PROCESS OF PURIFYING WATER BY IRRADIATING IT. Tanito, Keiko; Kato, Norio; Kinoshita, Shosaku; Kinoshita, Masahiro; Sunada, Tsuyoshi (to Osaka Prefecture). U. S. Patent 3,620,944. 16 Nov 1971. Priority date 9 Sep 1967, Japan.

Polluted water containing parathion, phenyl mercuric acetate, or methyl mercuric chloride can be purified by contacting the water with ionizing radiation (x rays, γ, or electron beams) for a sufficient period of time to destroy a sufficient amount of the pollutant to thereby purify the water. The dose of ionizing radiation must be about 5,000 to 1,000,000 rads. Additional steps may be necessary to remove the substances resulting from the irra-

diation from the water by sedimentation and filtration. (Offic. Gaz.)

17552 RADIOLYSIS OF COBALT HEXAMINE NITRATE IN SOLID MATRICES. Thomas, V. G.; Srivastava, S. B. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 9: No. 10, 1159-60(Oct 1971).

Cobalt-60 γ radiolysis of mixtures containing 1% cobalt hexaammine nitrate +99% matrix such as KCl, KBr, KI, SiO_2, CaO, MgO, Al_2O_3, ZrO_2, ZnO, TiO_2, and NiO was studied in powder form at room temperature. The insulators were found to be better sensitizers of the radiolysis than the semiconductors. On the other hand MgO, Al_2O_3, ZnO, TiO_2, and NiO exhibit protective effects on the radiolysis of the cobalt hexaamine cation as indicated by the Co(II) yield. (auth)

17553 CATION RADICAL IN A SINGLE CRYSTAL OF α-AMINOISOBUTYRIC ACID IRRADIATED BY γ RAYS AT 77°K. Minegishi, Atsuko; Shinozaki, Yoshiharu; Meshitsuka, Gisuke (Tokyo Metropolitan Isotope Research Center). J. Chem. Phys.; 56: No. 5, 2481-2(1 Mar 1972).

The cation radical was identified from the x-band ESR spectra of monoclinic single crystals of α-aminoisobutyric acid and its deuterated compounds irradiated by ^{60}Co γ rays at 77°K. (M.C.G.)

17554 MOLECULAR STRUCTURE EFFECTS ON THE FREE-ION YIELDS AND REACTION KINETICS IN THE RADIOLYSIS OF THE METHYL-SUBSTITUTED PROPANES AND LIQUID ARGON: ELECTRON AND ION MOBILITIES. Fuochi, P. G.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys.; 56: No. 5, 2333-41(1 Mar 1972).

The free-ion yields in liquid alkanes increase with increasing molecular sphericity and increasing temperature, in agreement with earlier observations. The Arrhenius temperature coefficient of free-ion formation is 0.8 kcal/mole in propane and 0.7 kcal/mole in 2-methylpropane. The free-ion yield in purified argon at 87°K appears to be $G_{fi} = 2.0$. Addition of oxygen to liquid argon decreased the free-ion yield, mainly because the efficiencies of electron energy loss processes with the diatomic oxygen molecules were much greater than those with monatomic argon molecules; the oxygen served to decrease the ion–electron separation distance more by de-energizing the electron than by scavenging it before it reached the end of its normal track. In pure liquid oxygen at 87°K, $G_{fi} = 0.013$. The ion–electron neutralization rate constant equals 8×10^{-5} cm^3/ion · sec in pure argon at 87°K and 3.1×10^{-4} cm^3/ion · sec in liquid methane at 120°K. The mobility of electrons in liquid methane is 300 cm^2/V · sec and decreases in other hydrocarbons with decreasing sphericity of the molecules. The Arrhenius temperature coefficient of electron mobility in 2-methylpropane is 3 kcal/mole. Ion–ion neutralization rate constants in the present liquids were all of the order of 10^{-9} cm^3/ion · sec, and the ion mobilities were all in the vicinity of 10^{-3} cm^2/V · sec. (auth)

17555 ENERGY TRANSFER STUDIES IN RADIOLYSIS OF BENZENE SOLUTIONS OF METAL TRISACETYLACETONATES: FLUORESCENCE QUENCHING. PART II. COBALTIC AND FERRIC TRISACETYLACETONATES. Srivastava, S. B.; Kalantri, O. P.; Shankar, J. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 9: No. 10, 1111-14(Oct 1971).

Quenching in benzene solutions containing scintillator PPO and quenchers cobaltic and ferric trisacetylacetonates was studied using both 253 nm and ^{60}Co as sources of excitations. Concave Stern–Volmer plots were obtained. On extrapolation γ_s was found to be $\sim 5.5 \times 10^3$ mole^{-1} for 253 nm excitation in both the cases whereas its values are $>9 \times 10^3$ mole^{-1} and $>3 \times 10^4$ mole^{-1} for high energy excitations. These correspond to $k_q \sim 2 \times 10^{11}$ mole^{-1} sec^{-1} for photoexcitation and 3×10^{11} to 1×10^{12} mole^{-1} sec^{-1} for high-energy excitations. In the latter cases, addition of N_2O reduces k_q values. Both the quenchers also decrease the phosphorescence intensity of benzene. The results appear to suggest that energy transfer is predominantly from $^1B_{2u}$ state of benzene. Analysis of the data on the basis of Förster mechanism yields theoretical transfer radius, $R_0 = 21$ Å. (auth)

17556 FLASH PHOTOLYSIS OF SULPHYDRYL AND DISULPHIDE COMPOUNDS IN AQUEOUS SOLUTION AND THE RATE CONSTANTS OF THEIR REACTIONS WITH HYDRATED ELECTRONS ($e^-_{aq.}$). Lal, Manohar (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 9: No. 10, 1108-10 (Oct 1971).

Using the machine for photogeneration of hydrated electrons (e^-_{aq}) designed by Schmidt and Hart [Adv. Chem., (1968), 81, 267], the rate constants of the reaction of hydrated electrons with certain sulfydryl and disulfide compounds were measured. Hydrated electrons could be optically generated in alkaline solutions of sulfydryl compounds according to the reaction $CyS^- + h\nu \rightarrow CyS + e^-_{aq.}$. The rate constants of $e^-_{aq.}$ with cysteine, cysteine-HCl, and cystine determined are in excellent agreement with those obtained by pulse radiolysis technique. The rate constants of reduced and oxidized glutathione were also determined and are within expectation. (auth)

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 17331, 17435, 17460, 17508, 18021, and 18262.

17557 (STI/PUB-294) RADIOPHARMACEUTICALS FROM GENERATOR-PRODUCED RADIONUCLIDES. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 11–15 May 1970. (International Atomic Energy Agency, Vienna (Austria)). Oct 1971. 211p. (CONF-700517). IAEA $6.00.

Twenty-one papers and a summary report on preparation and control of radiopharmaceuticals are included. Separate abstracts were prepared for 16 papers. Five papers were previously abstracted for NSA. For abstracts of these papers see CONF-700517 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 17435, 17560–17566, 17626–17631, 18021, and 19883.

17558 EFFECT OF SLOW ROTATIONAL DIFFUSION ON ANGULAR CORRELATIONS. Marshall, Alan G. (Univ. of British Columbia, Vancouver); Meares, Claude F. J. Chem. Phys.; 56: No. 3, 1226-9(1 Feb 1972).

The theory for perturbed angular correlations of gamma radiation has been extended to include the possibility of adiabatic variation in the interaction Hamiltonian, K, for the intermediate state. The calculation begins from a polycrystalline model; it is then shown that adiabatic variation in K introduces a time dependence into the angles which express the orientation of the molecular frame. If this variation arises from slow rotational diffusion of the principal axis of K, then each term of the polycrystalline correlation is simply modified to include the factor, $\exp[-k(k+1)Dt]$, where D is the rotational diffusion constant for molecular reorientation in the intermediate state. The relevance of the adiabatic limit to the use of perturbed angular correlations of gamma radiation for study of the motion of radioactive species in viscous media is discussed. (auth)

17559 PHARMACEUTICAL SUSPENSION AND METHOD OF STABILIZING. Hunter, William Ward Jr. British Patent 1,255,670. 1 Dec 1971. Priority date 14 Oct 1968, United States.

A method is described for the preparation of stabilized solutions of scanning agent for nuclear medicinal use by mixing a suspension of particles of the scanning agent with a water-miscible aliphatic polyhydric alcohol having at least 3 but not more than 7 C atoms. The method is applicable to the stabilization of suspensions of sulfur, strontium carbonate, or iron hydroxide labeled with radioactive isotopes or to radioiodinated albumin. (B.L.W.)

17560 RADIOPHARMACEUTICALS AND QUALITY CONTROL OF PHARMACEUTICAL PREPARATIONS. Kristensen, K. (National Health Service of Denmark, Copenhagen). pp 11-13 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

Rules and standards are suggested in preparation and handling of radiopharmaceuticals to ensure safe and efficient use. Personnel, premises, starting materials, operations, and quality control are discussed. (M.C.G.)

17561 PREPARATION AND QUALITY CONTROL OF ^{99m}Tc RADIOPHARMACEUTICALS BY THE AUSTRALIAN ATOMIC ENERGY COMMISSION. Boyd, R. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp 53-8 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

The Australian Atomic Energy Commission manufactures radiopharmaceutical preparations of ^{99m}Tc as a centralized service to the nuclear medicine departments of hospitals throughout

the Commonwealth of Australia. The paper describes the methods of production, quality control and distribution of sodium pertechnetate (^{99m}Tc) for brain scanning, ^{99m}Tc macroaggregated ferrous hydroxide for lung perfusion studies, and ^{99m}Tc rhenium sulfide colloid for scanning the reticulo-endothelial system. (auth)

17562 PREPARATION AND CONTROL OF ^{113m}In RADIOPHARMACEUTICALS. Cooper, J. F.; Wagner, H. N. Jr. (Johns Hopkins Medical Institutions, Baltimore). pp 83-9 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

The introduction of ^{113m}In generators into the nuclear medicine laboratory requires that suitable quality control measures be instituted to ensure the safety of patients. Recent developments in preparative methods and control procedures for ^{113m}In radiopharmaceuticals, in particular ionic indium, colloidal ^{113m}In phosphate, ^{113m}In-DPTA, ^{113m}In ferric hydroxide aggregates, and ^{113m}In-albumin microspheres, are described. General aspects of the control of ^{113m}In radiopharmaceuticals are discussed. (auth)

17563 USE AND BENEFIT OF KITS. Merlin, L. (CEN, Saclay, France). pp 145-8 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

The problems encountered in the use of kits for the preparation of radiopharmaceuticals from generator-produced radionuclides are discussed. Kits for the preparation of various ^{99m}Tc and ^{113m}In radiopharmaceuticals are discussed. Tests to be carried out on the various solutions used in the kits and on the final products are discussed. (auth)

17564 CONTROL OF PURITY, TOXICITY, STERILITY, AND APYROGENICITY OF THE FINAL PRODUCT. Tubis, M. (Veterans Administration Center, Los Angeles. Univ. of Southern California, Los Angeles). pp 149-56 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

The terms purity, toxicity, sterility, and apyrogenicity are defined for generator-produced radionuclides and their compounds as prepared in medical radioisotope laboratories. This class of radiopharmaceuticals poses special problems through the manner of production, preparation, and physical attributes. The tests for chemical, radiochemical, and radionuclidic purity, together with the biological tests and radiopharmaceutical quality control, are discussed. Recommendations and suggestions for the improvement of this class of radiopharmaceuticals are proposed. (auth)

17565 MEASUREMENT OF THE FINAL PRODUCT. Trott, N. G. (Royal Marsden Hospital and Inst. of Cancer Research, Sutton, Eng.). pp 157-62 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

A survey is given of the types of problem that arise in the measurement of radiopharmaceuticals before clinical use. Attention is drawn to the need for basic standards and for secondary calibration instruments. A short description is given of various types of systems used for reference purposes. The methods that may be used for the routine assay of samples before use are discussed. Some tables of typical calibration data are included. (auth)

17566 PRESENT AND FUTURE APPLICATIONS OF RADIOPHARMACEUTICALS FROM GENERATOR-PRODUCED RADIOISOTOPES. Wagner, H. N. Jr. (Johns Hopkins Medical Institutions, Baltimore). pp 163-5 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

Hot-Atom Chemistry

Refer also to abstracts 17476 and 19240.

17567 (COO-1617-29) HALOGEN ATOM REACTIONS ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ISOMERIC TRANSITION. Progress Report No. 6, February 1971-February 1972. (Nebraska Univ., Lincoln. Dept. of Chemistry). 15 Feb 1972. Contract AT(11-1)-1617. 224p. Dep. NTIS.

Research progress is reported on influence of rare gas moderators on ^{130}I reactions activated by radiative neutron capture and isomeric transition with methane, kinetic isotope effects on bromine reactions activated by radiative neutron capture in gaseous fluoromethane, effect of phase change on bromine reactions with bromomethane, gas phase reactions of ^{128}I activated by radiative neutron capture in ethylene and propylene, and kinetic energy spectra of hot atoms activated by radiative neutron capture. (M.C.G.)

17568 (IAEA-R-682-F) APPLICATION OF MOESSBAUER EFFECT IN THE STUDY OF RECOIL ATOMS IN SOLIDS AND SOLUTIONS AS RELATED TO THE HOT-ATOM METHODS OF ISOTOPE PRODUCTION USING A RESEARCH REACTOR. Final Report for the Period 1 October 1968-31 December 1970. Cheng, Hwa-Sheng (International Atomic Energy Agency, Vienna (Austria)). Jun 1971. vp. INIS.

The work performed under this contract comprises the following Moessbauer studies. (1) Moessbauer studies of iron hexacyanoferrate(II) and (III) complexes after (n,γ) reactions both in the solid state and in solution. The Moessbauer data are correlated with radiochemical data. (2) Correlation of Moessbauer spectra with radiochemical studies of neutron irradiated potassium hexacyanoferrate(II) solutions. (3) The relationship between Moessbauer spectra and radiochemical studies of neutron-irradiated potassium hexacyanoferrate(III) solutions. (4) A Moessbauer study of iron in reactor-irradiated pentacyano complexes and the radiation-induced conversion of the ammino iron carbonyl complexes. Dissolution of irradiated iron hexacyanocomplexes produced iron hydroxide and Prussian Blue from the Fe(II) and Fe(III) complexes, respectively. These compounds were not detectable by Moessbauer experiments. In both studies of solutions and solids of the iron hexacyano complexes, evidence was obtained of reagent catalyzed reactions. Moessbauer experiments on irradiated pentacyano complexes showed the value of the method in studying trapped species. Ammino complexes of Fe(III) were converted to nitrosyl complexes on prolonged irradiation. (INIS)

17569 PENETRATING POWER OF β-DECAY RECOILS OF EPITHERMAL ENERGIES IN ORGANIC MATTER. Shafrir, N. H. (Technion-Israel Inst. of Tech., Haifa). Can. J. Chem.; 49: No. 22, 3692-9(15 Nov 1971).

A method for the measurement of the extent of dislocation of the β-decaying nucleus from its equilibrium position is described. An ionized layer formed at the surface of an aqueous solution of an ionic surface-active substance served as a source of β-disintegrating atoms. The primary adsorbed surface-active ions give rise to an electrical double layer within the liquid phase. When the solution contains β-active ions, some will join the electrical double layer near the surface as counter ions. It was found that radioactive β-recoils arising in an adsorbed surface layer are able to leave the surface, collected on a negatively charged plate, and counted. In order to reach the gas phase, the β-recoils have to penetrate the primary organic adsorption layer. When the expanded adsorption layer is gradually compressed, particles of lower energy are stopped, resulting in decreased recoil activity. Extrapolation to zero β-recoil activity gives an approximate value for the mass per unit area of organic material which stops completely atoms of certain initial energy. For particle energies between 2 and 22 eV, a linear dependence is found between the maximum β-recoil energy and the "penetrating power." The corresponding organic stopping layers for this energy region are between 1.0 and about 1.6×10^{-7} g/cm^2. (auth)

17570 EFFECT OF MODERATORS ON THE ISOMERIC TRANSITION INDUCED REACTIONS OF ^{130}I AND ^{82}Br WITH METHANE AND d-METHANE. Nicholas, James Blair. Lincoln, Neb.; Univ. of Nebraska (1971). 376p. University Microfilms Order No. 72-172.

Thesis.

The effects of various rare gas additives in moderating the reactions of (n,γ) and (IT) activated ^{130}I and (IT) activated ^{82}Br with CH_4 and CD_4 were determined in order to ascertain the reaction mechanisms. The organic yields for the ^{129}I(n,γ)^{130}I and $^{130\,m}$I(IT)^{130}I processes in gaseous mixtures of CH_4 or CD_4 and $CH_3{}^{129}$I were compared in an attempt to determine what fraction of the ^{130}I atoms formed in the two processes reacts as a result of charge and what fraction reacts as a result of kinetic energy. Similarly, the organic yield of ^{130}I from the ^{129}I(n,γ)^{130}I reaction was compared with that for the ^{128}I from the ^{127}I(n,γ)^{128}I reaction to study the activation resulting from the two (n,γ) processes.

These studies were made as a function of the nature and amount of rare gases in determining the fate of the activated atoms. The role of excess kinetic energy and thermal processes in the ^{82}Br reaction in gaseous CH_4 and CD_4 activated by ^{82m}Br isomeric transition was determined using rare gas and bromine additives. Possible isotope effects were investigated between (n,γ)-induced ^{80}Br and ^{80m}Br and CH_4 and CD_4 target molecules. (TSS)

Properties of Radioactive Materials

Refer also to abstracts 17404, 17456, and 17472.

17571 (CEA-N-1441) OXIDATION-REDUCTION REACTIONS WITH TRANSURANIC ELEMENTS IN SOLUTION. Gourisse, Daniel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1971. 103p. (In French). Dep. NTIS (U. S. Sales Only).

A systematic review of oxidation-reduction reactions in aqueous solutions (disproportionation, synproportionation, isotopic exchange, and reactions with oxidizing and reducing agents) for transuranium elements (Z = 93 to 102) is proposed. After a detailed review of the present knowledge on the equilibria and rates of these reactions, the general characteristics of their kinetics are discussed on the basis of absolute reaction rate theory (absolute reaction rates, standard entropy of activated complexes, activation energy, effects of acidity, ionic strength, anions on the reaction rate and reaction mechanisms). (France)

17572 (SZS-13/71 (pp 1-19)) INVESTIGATIONS ON THE IMPROVEMENT OF TEXTILE DECONTAMINATION. Unger, H.; Richter, K.-J.; Kutz, I. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

Studies were performed aimed at improving and optimizing the cleaning process for radioactively contaminated cotton and cellulose textiles. Clothing contaminated with model contaminants or by use in a nuclear power plant was treated on a laboratory scale and in a laundry, respectively. Effective cleaning was achieved by the use of agents containing polyphosphates, thus keeping the pH of the cleaning solution below 9. Furthermore, good results were obtained in a weakly acidic medium (with or without addition of oxalate or citrate). The decontaminability of normally and highly improved cotton and of mixed textiles made of polyester or polyacrylonitrile fibers and cellulose fibers was examined. The most favorable properties showed mixed textiles consisting of polyester and cotton or viscose. (auth)

17573 (UJV-2572-Ch) SORPTION OF GASEOUS URANIUM HEXAFLUORIDE ON SOLID BARIUM FLUORIDE. Korinek, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb 1971. 48p. (In Czech). INIS.

The reaction mechanism was studied of the sorption of gaseous uranium hexafluoride on solid barium fluoride. Up to 150°C, UF_6 reacted with BaF_2 yielding a complex compound with the general formula $UF_6 \cdot xBaF_2$, formed on the BaF_2 particles in a very thin layer. The first contact of gaseous BaF_2 with UF_6 resulted in the formation of a small amount of UF_4. In this temperature range, no side reactions of UF_6 were observed. At temperatures between 150 and 220°C, UF_6 molecules diffused through the complex layer. The reaction rate increased with increasing UF_6 pressure, but in no case a compound with a well-defined stoichiometric value x was obtained. Above 220°C, side reactions prevailed resulting in the reduction of UF_6 to UF_4: $2UF_6 \cdot xBaF_2 \rightarrow (UF_5)_2BaF_2 + (2-x)BaF_2 + F_2$, $(UF_5)_2BaF_2 \rightarrow (UF_4)_2BaF_2 + F_2$, $(UF_4)_2BaF_2 \rightarrow 2UF_4 + BaF_2$, $UF_6 + UF_4 \rightarrow 2UF_5$. The last compound was unstable and again decomposed, but in this way one molecule of UF_6 was removed from the reaction with BaF_2. Thermogravimetric analysis proved the stability of $UF_6 \cdot xBaF_2$; up to 500°C no thermal effects were observed; the small weight loss observed was rather characteristic of the reaction of UF_6 with H_2O yielding $UO_2F_2 + 4HF$ than of the liberation of UF_6; the water probably originated from the humidity of the inert gas. (INIS)

17574 (USIP-71-9) SPECTROSCOPIC STUDIES OF THE DIATOMIC MOLECULES HfO AND ThO. Edvinsson, Gunnar (Stockholm Univ. (Sweden). Inst. of Physics). Nov 1971. 19p. Dep. NTIS (U. S. Sales Only).

A comparison is made between HfO and ThO spectra. In the HfO spectrum, 9 band systems are identified in the visible and ultraviolet region (3,000 to 7,000 Å). In the ThO spectrum, there are many more band systems in the same wavelength region and the spectrum looks quite unlike that of HfO. In spite of the difference in appearance of the two spectra, it is possible to find counterparts in ThO for most of the electronic states found for HfO, but there are also several strong bands in ThO that have not been analyzed. (auth) (Sweden)

17575 RADIOCHEMICAL PURITY OF THE COMPLEX OF ^{113m}In WITH DIETHYLENETRIAMINEPENTAACETIC ACID. Besnard, M.; Gaucher, Ch.; Merlin, L. (CEN de Saclay, Gif-sur-Yvette, France). J. Radioanal. Chem.; 9: No. 1, 73-9 (Oct 1971). (In French).

The radiochemical purity of the ^{113m}In-DTPA complex is determined by two methods whose principle is different: filtration on "Sephadex" gel, and ascending paper-chromatography. The two techniques give slightly different values for non-complexed indium; any way less than 5% mean value. They show that the reproducibility of the method used to prepare the compound is satisfactory. (auth)

17576 COMPLEX FORMATION OF PLUTONIUM(III) AND NEPTUNIUM(V) WITH ANIONS OF CERTAIN HYDROXY ACIDS. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 598-603(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 582-8(Jul-Aug 1971).

The ion-exchange behavior of Pu^{3+} in solutions of hydroxy acids (lactic, glycolic, trihydroxyglutaric, and α-isobutyric) was studied. The composition and stability constants of complexes of Pu^{3+} with various anions of hydroxy acids, formed under the investigated experimental conditions, were determined. The ion-exchange behavior of NpO_2^+ in solutions of α-hydroxyisobutyric acid was studied, and the composition and stability constants of the complexes $NpO_2(o\text{-But})_j^{1-j}$ (where j = 1, 2, and 3) were determined. Certain factors associated with the formation of rings and influencing the stability of complexes of trivalent actinides with mono- and dicarboxylic hydroxy acids are revealed. (auth)

17577 INVESTIGATION OF THE COMPLEX FORMATION OF Pu(III), Am(III), AND Cm(III) WITH NITRILOTRIACETIC AND DIETHYLENEPENTAAMINEACETIC ACIDS. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 592-7(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 575-81(Jul-Aug 1971).

The ion exchange behavior of Pu^{3+}, Am^{3+}, and Cm^{3+} in solutions containing NTA and DTPA was studied. The composition of nitrilotriacetate complexes of the type of MA^0 and diethylenetriaminepentaacetate complexes of the MA^{2-} type was determined. Their concentration and thermodynamic stability constants were calculated and compared with the literature data. Some principles of the complex formation of trivalent actinides with complexones were found. The dependence of the stability of their complexonates on the properties of the central atom and of the complexone was established; factors associated with the formation of rings are revealed. (auth)

17578 COMPLEX FORMATION OF URANIUM(IV), NEPTUNIUM(IV, VI), AND PLUTONIUM(IV, VI) IN ACETATE SOLUTIONS. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 587-91(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 570-5(Jul-Aug 1971).

The ion exchange behavior of tetravalent uranium, neptunium, and plutonium in acetate solutions was studied. It was established that under the experimental conditions investigated, acetate complexes of U(IV), Np(IV), and Pu(IV) are formed with a M:ligand ratio varying successively from 1 to 8. Their stability constants were calculated. The formation of neptunyl and plutonyl in acetate solutions was investigated by the method of potentiometric titration. The composition and concentration (at $\mu = 1$) stability constants of acetate complexes of NpO_2^{2+} and PuO_2^{2+} formed under the given experimental conditions were determined. (auth)

17579 STRUCTURE OF UO_2MoO_4. Serezhkin, V. N.; Kovba, L. M.; Trunov, V. K. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 680(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 659(Jul-Aug 1971).

UO_2MoO_4 was produced and studied by x-ray diffraction. It crystallizes in monoclinic symmetry, a = 7.195 ± 0.012, b = 5.484 ± 0.007, c = 13.58 ± 0.02Å, $\beta = 104.57 \pm 0.13°$, space group $P2_1/C$, Z = 4, $P_e = 5.46$ g/cm³, $P_v = 5.51$ g/cm³. The coordinates of uranium and molybdenum atoms were determined. (M.C.G.)

17580 INCORRECT IDENTIFICATION OF Am(VII). Zaitseva, V. P. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 679 (Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 658-9(Jul-Aug 1971).

A paper [V. P. Zaitseva, Dokl. Akad. Nauk SSSR, 188, No. 4, 826(1969)] indicated that americium can be produced in the heptavalent state by alkalinization of an acid solution of Am(VI), as well as by the action of strong oxidizing agents on a suspension

of Am(V) hydroxide in alkaline solution. Verifying experiments showed the red color of the solution and its spectrum are due to Fe(VI) not Am(VII). (M.C.G.)

17581 STABILITY OF ACETATE COMPLEXES OF SCANDIUM AND THORIUM IN WATER AND AQUEOUS ETHANOL MIXTURES. Usherenko, L. N.; Skorik, N. A. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 665-7(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 646-8(Jul-Aug 1971).

The stability of scandium and thorium acetate complexes in water and in mixtures containing 25 and 50 vol % ethanol was studied. The dependence of log β_1 (β_1 = [MA]/[M][A]) on the dielectric permeability of the solvent was investigated. (M.C.G.)

17582 ENTHALPY OF THE FORMATION OF URANIUM TRIOXIDE DIHYDRATE. Santalova, N. A.; Vidavskii, L. M.; Dunaeva, K. M.; Ippolitova, E. A. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 608-12(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 592-7(Jul-Aug 1971).

The enthalpy of formation of $UO_3 \cdot 2H_2O$, based on the value of the enthalpy of formation of UF_6, was determined. A detailed description is given of the method of synthesis of the compound, as well as data from chemical and x-ray diffraction analyses. The values $\Delta H_{f298.15°K}$ $UO_3 \cdot 2H_2O_{sol} = -439.61 \pm 1.86$ kcal/mole and $\gamma\text{-}UO_{3sol} + 2H_2O_{liq} = UO_3 \cdot 2H_2O_{sol}$ $\Delta H^0_{298.15°K} = -7.19 \pm 0.27$ kcal/mole were obtained. (M.C.G.)

17583 DEACTIVATION OF SOLUTIONS AND THE SOLUBILITY PRODUCTS OF HYDROXIDES. Benes, P. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 682-3(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 661(Jul-Aug 1971).

In studies on decontamination of solutions by coagulation, the efficiency of the process is calculated on the basis of the solubility products of the hydroxides of the corresponding elements. An evaluation of solubility products is discussed. (M.C.G.)

17584 MOLYBDOTHORIC ACID (A HETEROPOLY ACID) AND ITS COMPLEXING REACTIONS. Torchenkova, E. A.; Baidala, P.; Smurova, V. S. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 199: No. 1, 120-3(1 Jul 1971). (In Russian).

Certain characteristics of solutions of molybdothoric acid (TMA) and its ammonium salt were studied. The product of boiling solutions of ammonium paramolybdate and thorium nitrate together is believed to have the formula $(H_3O)_6H_2 \cdot [ThMo_{12}O_{42}] \cdot 12\ H_2O$. Interplanar distances in the crystal were measured. Neutralization curves confirm the proposed octabasic nature of TMA. Light absorption curves at various values of pH (220 to 280 mμ) were constructed, which portray a maximum at 248 mμ that becomes more prominent at high pH values. Crystalline TMA showed a tendency to decompose during several months storage. (K.S.W.)

17585 INVESTIGATION OF THE COMPLEX FORMATION OF TRIVALENT ACTINIDE AND LANTHANIDE ELEMENTS BY THE METHOD OF ELECTROMIGRATION. X. GRAPHICAL ANALYSIS OF THE ELECTROMIGRATION CURVES. Shalinets, A. B.; Stepanov, A. V. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 579-82(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 562-6(Jul-Aug 1971).

Methods of determining the composition of complex ions containing actinides and lanthanides from electromigration data are discussed. A method of graphical analysis of the electromigration curves, permitting (together with a determination of the stability constants of the mononuclear complexes) a verification of the reality of the proposed composition of the complex ions is suggested. (auth)

17586 INVESTIGATION OF THE COMPLEX FORMATION OF TRIVALENT ACTINIDE AND LANTHANIDE ELEMENTS BY THE METHOD OF ELECTROMIGRATION. XI. RELATIONSHIP OF THE STRENGTH OF COMPLEXES TO THE STRENGTH OF THE ACID. Shalinets, A. B. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 583-6(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 566-70(Jul-Aug 1971).

Total stability constants of actinide and lanthanide complexes, calculated by graphical analysis of electromigration curves, are given. All the polyaminopolyacetic complexones for normal complexes and not more than one protonated complex. Organophosphorus complexones form a set of protonated complexes in addition to the normal complexes. (M.C.G.)

17587 PRODUCTION OF SOLID COMPOUNDS OF NEPTUNIUM(III) FROM AQUEOUS SOLUTIONS. Mefod'eva, M. P.; Gel'man, A. D. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 613-18(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 597-603(Jul-Aug 1971).

Compounds of neptunium(III) with oxalate, phenylarsonate, salicylate, and fluoride ions, as well as complex sulfates with potassium and sodium, were isolated in the solid form from aqueous solutions. The composition of the isolated compounds, their purity, and stability to oxidation were established. In solid compounds the stability of trivalent neptunium to oxidation is increased. Precipitation of neptunium(III) in the form of the complex sulfate $K_5Np(SO_4)_4$ can be recommended for isolation in the pure form without any impurity of the tetravalent form. In the dry form the complex sulfates of trivalent neptunium are stable to oxidation during prolonged storage and even at increased temperature. (auth)

17588 COMPLEX FORMATION OF NEPTUNIUM(IV, V) AND PLUTONIUM(IV) WITH DIETHYLENETRIAMINEPENTAACETIC ACID. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 659-61(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 641-3(Jul-Aug 1971).

The ion-exchange behavior of neptunium(IV,V) and plutonium(IV) in solutions containing DTPA was studied. The processes of complex formation of Np(IV) and Pu(IV) go to completion in the interval of DTPA concentrations from 2.5×10^{-5} to 4×10^{-3} M at a constant hydrogen ion concentration equal to 0.5 M. It was established that under the experimental conditions investigated, Np(IV) and Pu(IV) form 1:1 complexes with the anion A^{5-}. The concentration (at μ = 1) stability constants of the complexes NpA^- and PuA^- were calculated; their values are correspondingly equal to 6.1×10^{29} and 2.4×10^{29}. It was found that the processes of complex formation of NpO_2^+ go to completion in the interval of DTPA concentrations from 1×10^{-4} to 1×10^{-2} M at pH = const = 6.0. The composition and concentration (at μ = 0.05) stability constants of the complex NpO_2A^{4-} were determined; the stability constant is equal to 6.8×10^{10}. (auth)

17589 DECONTAMINATION OF SURFACES CONTAMINATED WITH RADIOLUMINESCENT TRITIUM PAINT. Miazek-Kula, M. Pr. Cent. Inst. Ochrony Pracy; 21: No. 68, 51-64(1971). (In Polish).

The decontamination of surfaces of steel, aluminum, vinidur, plexiglass, glass, oil paint and waterproof paint, vinileum, poly(vinyl alcohol), and polyethylene foils as well as rubber designed for the production of safety gloves, contaminated with tritium paint or with an aqueous suspension of radioactive powder on the basis of which this paint is produced, is discussed. The influence of decontaminating agent type, decontamination time, number of contamination-decontamination cycles, and contamination time on the decontamination coefficient was investigated. Research was carried out, too, on the relation between luminosity of the sample under the influence of ultraviolet radiation and the decontamination coefficient, as well as on the degree of tritium (contamination) penetration through some materials, particularly through rubber for production of gloves. On the basis of results of investigations, practical conclusions were drawn. (auth)

17590 INTERACTION OF MALONATE COMPLEXES OF URANYL WITH HYDROGEN PEROXIDE. I. INVESTIGATION OF THE SOLID PHASE IN THE SYSTEM $UO_2(NO_3)_2$–H_2O_2–$R_2C_3H_2O_4$–H_2O. Gurevich, A. M.; Polozhenskaya, L. P.; Solntseva, L. F.; Osicheva, N. P. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 604-7(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 588-92(Jul-Aug 1971).

Methods were developed for the synthesis of peroxomalonate complex compounds of uranyl of the type $R_2[(UO_2)_2(OO)_2(Mal)(H_2O)_n] \cdot mH_2O$, $R_4[(UO_2)_2(OO)_2(Mal)_2(H_2O)_n] \cdot mH_2O$, $R_4[(UO_2)_2(OO)(Mal)_3 \cdot (H_2O)_n] \cdot mH_2O$, and the reactions involved in their production were studied. (auth)

17591 COMPLEXING IN THE SOLUTIONS OF URANYL SULPHATE AT ELEVATED TEMPERATURES. Nikolaeva, N. M. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 14, Ser. Khim. Nauk; No. 6, 62-5(Nov 1970). (In Russian).

The dissociation constants of uranyl sulfate were determined by the method of conductivity for the reaction: $UO_2SO_4 \rightleftharpoons UO_2^{2+} + SO_4^{2-}$ at 25, 50, 70, and 90°C. The values of the constants were equal to 4.45×10^{-4}, 3.31×10^{-4}, 2.40×10^{-4}, and 1.29×10^{-4}, respectively. The ΔH^0 varies in the range from −2.23 to −7.64 kcal/mole. (auth)

17592 FORMATION CONSTANTS OF THORIUM HYDROXY-COMPLEXES DETERMINED BY THE METHOD OF POTENTIO-

METRIC TITRATION. Kiciak, Stanislaw; Stefanowicz, Tadeusz (Polytechnical Univ., Poznan, Poland). Rocz. Chem.; 45: No. 11, 1801-6(1971).

The formation constants of thorium hydroxide complexes were determined by the method of potentiometric titration. Stock solutions of thorium nitrate were pipeted to titration beakers, a known amount of acid introduced, water added, and then NaOH added from a microburet. After equilibrium was reached the pH values were recorded. Experimental and calculated $\bar{n}_{OH}$ values are given. (M.C.G.)

17593 EXCHANGE REACTIONS IN THE ION SOURCE OF A MASS SPECTROMETER. Cichorz, Roger S. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Appl. Spectrosc.; 26: No. 1, 104-5(Jan-Feb 1972).

Exchange reactions occurred in the ion source of a mass spectrometer during direct solid probe analyses of tetra(cyclopentadienyl)uranium(IV) and the mass spectrum of tris(cyclopentadienyl)-uranium(IV) fluoride was obtained. (M.C.G.)

17594 ELECTROCHEMICAL STUDY OF URANIUM(VI) IN AQUEOUS SOLUTION OF TRI-n-BUTYL PHOSPHATE. Krznaric, D.; Cosovic, B.; Branica, M. (Inst. Rudjer Boskovic, Zagreb). J. Electroanal. Chem. Interfacial Electrochem.; 33: No. 1, 61-8(Nov 1971).

The adsorption of TBP at the mercury electrode was investigated by drop time and tensammetric measurements. The adsorption occurs in the potential range from approximately 0 to −1.3 V vs. SCE. The interaction of uranyl ion and TBP in aqueous solutions and in the adsorbed layer on the mercury electrode surface, was examined by means of polarography. In the presence of TBP the reduction wave of uranium(VI) splits into a reversible wave at −0.17 V and an irreversible one at −0.3 V. A bridge mechanism of electron transfer at the surface covered with TBP is suggested. TBP was observed to disappear from the examined solutions during the process of aging and this is attributed to the slow formation of a complex of uranium(VI) with TBP in the bulk of the solution. (auth)

17595 CYCLIC VOLTAMMETRIC INVESTIGATION OF Pu(IV) REDUCTION BY HYDROXYLAMINE IN NITRIC MEDIA. Casadio, Sergio; Orlandini, Franco (CNEN-CSN, Rome). J. Electroanal. Chem. Interfacial Electrochem.; 33: No. 1, 216-18 (Nov 1971).

The relative homogeneous rate constant for reduction of plutonium(IV) by hydroxylamine can be obtained by voltammetric techniques. Values were consistent with the reaction $2Pu^{4+} + 2NH_3OH^+ \rightleftharpoons 2Pu^{3+} + N_2O + H_2O + 5H^+$. The rate constant was 0.53 ± 0.03 l s^{-1} $mole^{-1}$ at 25.0 ± 0.2°C. (M.C.G.)

17596 PRODUCTION OF URANYL FLUORIDE. Rode, James Allen (to United Nuclear Corp.). British Patent 1,260,562. 19 Jan 1972. Filed 31 Jul 1969.

Difficulties associated with present processes for the production of UO_2F_2 from UF_6 are stated, and a new and improved hydrolytic process is claimed. Steam and gaseous UF_6 are introduced separately into a reaction zone having a fluidized bed of UO_2F_2 particles. The UF_6 is introduced at a temperature of at least 200°F and a rate of at least 5000 cfh per square inch of nozzle opening, in order to prevent formation of solids prior to reaction with steam in the fluidized reaction zone. The relative concentrations of the UF_6 and steam in the reaction zone are regulated so that the amount of steam used is above, but not in excess of 300% of, the stoichiometric requirement for the hydrolysis reaction. The temperature in the reaction zone is maintained above 500°F but below 900°F, to promote surface reaction on the fluidized UO_2F_2 particles, and sufficient UO_2F_2 seed particles are maintained in the reaction zone to stabilize the average particle size therein. The hydrolysis is preferably carried out in the presence of an inert gas diluent, such as N_2. The process is continuous, and the product is less hygrascopic then with present processes, has substantially uniform particle size of about +60 mesh, is free flowing, and has high bulk density. A major advantage is stated to be a great reduction in the amount of fines recycle required to maintain particle size stability. A flowsheet is given, together with examples of application of the process. (UK)

17597 IMPROVEMENTS IN METHODS AND APPARATUS FOR THE OBTAINMENT OF URANIUM FLUORIDE. Delange, Maurice; Huet, Henri; Vertes, Paul. Australian Patent 418,876. 11 Nov 1971. Priority date 12 Jan 1965, France.

An apparatus for the manufacture of uranium fluoride by the reaction of hydrofluoric acid gas (HF) with uranium oxide (UO_2) is described. The apparatus comprises a furnace and a cooling zone through which the acid gas and the uranium oxide are arranged to flow countercurrent. The cooling zone is disposed downstream of the furnace in the direction of flow of the hydrofluoric acid gas and has a temperature sufficiently lower than the reaction temperature of the furnace to ensure the absorption of residual hydrofluoric acid gas. Means are also provided for controlling the rate of feed of hydrofluoric acid gas to the furnace or the rate of flow of the uranium oxide in accordance with the temperature of the uranium oxide entering the zone, to cause the apparatus continuously to produce an optimum yield of uranium fluoride. (Australia)

17598 SIMPLE SYSTEM FOR TRANSFERRING AIR-SENSITIVE COMPOUNDS INTO CAPILLARIES FROM SCHLENK TUBES. Eggerman, W. G. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Appl. Spectrosc.; 26: No. 1, 112-13 (Jan-Feb 1972).

A transfer device for air-sensitive organoactinide compounds is described. The basic design consists of a Schlenk tube with a standard taper joint, a machined Teflon stopper, and a capillary tube. A hole is drilled in the stopper to accommodate the tube, with a fit tight enough to maintain a reasonable vacuum. A funnel is machined into the stopper base. After filling, the capillary is flamed off to seal the air-sensitive sample in the tube. (M.C.G.)

17599 CHEMICAL REACTIONS IN FUSED SALTS. 2nd PART. Landresse, G. Ind. Chim. Belge; 36: No. 11, 950-62(Nov 1971). (In French).

The oxidation-reduction reactions taking place in fused salts are described. The reactions are divided into those with the participation of the solvent and those without. Uranium and plutonium systems in fused chlorides, along with Ag, Pb, Sn, Cd, Zn, Mg, Cd, Ce, Au, Pt, and Co systems, are discussed. The E^0/pO^{--} diagrams of U in fused chlorides are considered. The U−Pu separation, dissolution of uranium oxides, chlorination of UCl_4 by Cl_2, oxidation of UCl_4 into uranyl, and particular actinide reactions in heterogeneous gas−solution phases are discussed. U, Th, and Np reactions in heterogeneous liquid−solid phases are considered. Uranium oxidation-reduction reactions in fused LiCl−KCl systems are discussed. (J.S.R.)

17600 METHOD AND MEANS FOR REMOVAL OF RADIOACTIVE CONTAMINANTS. Moroni, R.; Rinch, F. K.; Kisteneich, P. (to Colo-Rheincollodium-Koeln GmbH). Canadian Patent 883,357. 12 Oct 1971. Priority date 4 Jun 1965, Germany.

To remove contaminents from the skin and other surfaces, an open-celled synthetic foam body is employed. Cell walls have skin-scraping sharp edges, which gather contaminents which are carried off in the scrubbing action. The foam has incorporated therein 1 to 25% of a material selected from absorbent, adsorbent and ion exchange substances. Both liquid and solid radioactive contaminants can be handled by this treatment. The foam body is derived from polyurethane foam, phenol resin foam, polystyrene foam, and buna or natural rubber base foam. (F.S.A.) (Canada)

17601 PREPARATION OF URANIUM TETRAFLUORIDE BY HYDRAZINE REDUCTION OF URANIUM(VI) IN ACIDIC SOLUTION. Ishijima, Itaru (Tokyo Inst. of Tech.); Sakuma, Hikoya; Funaki, Koemon. Kogyo Kagaku Zasshi; 74: No. 10, 1996-2003(Oct 1971). (In Japanese).

The preparation of uranium tetrafluoride by hydrazine reduction of uranyl chloride−hydrochloric acid solution in the presence of hydrofluoric acid was examined. The reduction rate of U(VI) to U(IV) in the solution was measured at 95°C under various conditions. The reduction rate increased with increasing flow rate of inert gases through the solution, and reduction rates were higher in the flow of argon than in the flow of nitrogen. A reduction rate of 96.4% was attained by the reduction of uranyl chloride solution containing 5.0 g of U(VI), 2.5 mol of N_2H_4, 2.5 mol of HF, and 5.0 mol of HCl per liter at 95°C for 12 hours in the flow of argon. The reduction product was a green, fast settling, easily separable precipitate with composition corresponding to a hydrazine uranium(IV) fluoride complex, $UF_4 \cdot \frac{1}{2}(N_2H_4 \cdot 2HF)$. However, this complex was unstable in water, and converted to a hydrazine uranium(IV) fluoride hydrate complex expressed as $UF_4 \cdot m(N_2H_4 \cdot HF) \cdot nH_2O$ ($m \leq 0.5$, $n \leq 2$) on washing with water. Anhydrous uranium tetrafluoride can be easily obtained from these complexes by thermal decomposition at 400°C. Some considerations on the mechanism of hydrazine reduction of U(VI) in acidic solution were also discussed. (auth) (Japan)

17602 METHOD AND APPARATUS FOR THE MEASUREMENT OF THE ACTIVITY OF A MATERIAL IN A MIXTURE CONTAINING SEVERAL RADIOACTIVE MATERIALS. Plesch, Diether (to Gesellschaft fuer Kernforschung mbH). German Patent 1,489,925. 4 Sep 1969. Filed 1 Jul 1965. (In German).

A procedure for the measurement of the activity of a previously

determined material in a mixture containing several radioactive materials is described. The activity of the mixture containing the previously determined material is measured, the previously determined material is separated, and the activity of the remaining material is measured again. The difference between the two measurements is calculated. This method is used for measurement of tritium activity in gases that contain other radioactive materials in addition to tritium. (tr-auth)

17603 METHOD OF DECONTAMINATING RADIOACTIVE METAL SURFACES. Jordan, William T.; Zimmerman, Cort A. (to United States Atomic Energy Commission). U. S. Patent 3,615,817. 26 Oct 1971. Filed 4 Feb 1969.

A method of decontaminating radioactive metal surfaces, and particularly difficultly accessible radioactive surfaces such as the ceiling and walls of a reactor vessel, comprises carrying a decontaminating reagent to the surfaces in a foam. Consecutive applications of alkaline permanganate and oxalic acid in foam give particularly good results. A nonionic foaming agent should be employed when the foaming agent may come into contact with a solution containing aluminum ions. (Offic. Gaz.)

17604 HEAT CAPACITY OF POTASSIUM PERTECHNETATE FROM 10 TO 310°K. ENTROPY AND GIBBS ENERGY. ENTROPY OF THE AQUEOUS PERTECHNETATE ION. Busey, R. H.; Bevan, R. B. Jr.; Gilbert, R. A. (Oak Ridge National Lab., Tenn.). J. Chem. Thermodyn.; 4: No. 1, 77-84(Jan 1972).

The heat capacity of potassium pertechnetate was determined over the temperature range 10 to 310°K and the standard thermodynamic functions for the compound are tabulated. The standard thermodynamic functions at 298.15°K are $C_p^0 = 29.47$ cal_{th} K^{-1} mol^{-1}, $S^0 = 39.38$ cal_{th} K^{-1} mol^{-1}, $\{H^0(T) - H^0(0)\}/T = 18.972$ cal_{th} K^{-1} mol^{-1}, and $-\{G^0(T) - H^0(0)\}/T = 20.411$ cal_{th} K^{-1} mol^{-1}. Auxiliary data together with an estimated activity coefficient lead to $S^0(TcO_4^-, aq) = (47.2 \pm 0.3)$ cal_{th} K^{-1} mol^{-1} for the standard entropy of the aqueous pertechnetate ion at 298.15 K. (auth)

17605 STUDY OF THORIUM(IV) COMPLEXES OF HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID BY POTENTIOMETRIC METHOD. Mathur, R. P.; Nath, P.; Kapoor, R. C. (Univ. of Jodhpur, India). Indian J. Chem.; 9: No. 10, 1161-2 (Oct 1971).

Potentiometric titration of Th(IV) with hydroxyethylethylenediaminetriacetic acid indicated the formation of the complex species $M(H_2AOH)_2$, $M(AAOH)_2$, and $M(HOH)_2$. The stepwise formation of the complex is not possible, as revealed by the formation curves. The values of log K_2 and $-\Delta F$ are found to be 6.0 ± 0.15 and 8.37 ± 0.2 kcal/mole, respectively. (auth)

17606 ENTHALPY OF URANIUM TETRAFLUORIDE FROM 298 TO 1400°K: ENTHALPY AND ENTROPY OF FUSION. Dworkin, A. S. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 34: No. 1, 135-8(Jan 1972).

The enthalpy of UF_4 from room temperature up into the liquid phase was measured in order to clarify some questionable thermochemical behavior reported in the literature. The measured entropy of fusion for UF_4 of 8.6 cal $°K^{-1}$ mol^{-1} is considerably lower than the 12.7 cal $°K^{-1}$ mol^{-1} reported for the isostructural compound ZrF_4. However, at 1400°K the absolute entropy of UF_4 is seven entropy units higher than that for ZrF_4. No evidence for a solid state transition in UF_4 was found. (auth)

17607 VARIATION OF LATTICE PARAMETER WITH HYDROGEN CONTENT OF NON-STOICHIOMETRIC PLUTONIUM DIHYDRIDE. Muromura, T.; Yahata, T.; Ouchi, K.; Iseki, M. (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 34: No. 1, 171-3(Jan 1972).

The relation between composition and lattice parameter of nonstoichiometric plutonium dihydride (cub.) was studied. The samples were prepared by two different methods, namely, thermal decomposition of $PuH_{3.0}$ and hydrogenation reaction of the lower hydrides. As the H/Pu mole ratio increased from 2.0 to 2.7, the lattice parameter of PuH_{2+x} lineally decreased from 5.360 to 5.340 Å. The influence of the oxidation on the lattice parameter is also given. (auth)

17608 FORMAL POTENTIAL OF THE Bk(IV)–Bk(III) COUPLE IN SEVERAL MEDIA. Stokely, J. R.; Baybarz, R. D.; Peterson, J. R. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 34: No. 1, 392-3(Jan 1972).

In conjunction with investigations on the solution absorption spectra of berkelium(IV) direct potentiometric measurements were made of the formal reduction potential of the Bk(IV) – Bk(III) couple in a variety of aqueous media. With the recent availability of multimicrogram quantities of ^{249}Bk, direct potentiometric measurement to obtain the formal potential of the Bk(IV) – Bk(III) couple became possible. Other potential measurements were made with tracer quantities by indirect techniques in HNO_3, H_2SO_4, and $HClO_4$ media. The formal potential of the Bk(IV) – Bk(III) couple in 1 M $HClO_4$, 1 M HNO_3, 7.5 M H_3PO_4, and in 2 M K_2CO_3 is reported. (UK)

17609 OPTICAL ABSORPTION SPECTRA AND MAGNETIC MEASUREMENTS ON COMPOUNDS OF THE TYPE $M^{II}U_2^{V}F_{12} \cdot 4H_2O$(M = Co,Ni,Cu). Montoloy, F. (CEN de Saclay, Gif-sur-Yvette, France); Plurien, P.; Capestan, M. J. Inorg. Nucl. Chem.; 34: No. 1, 125-33(Jan 1972). (In French).

From the study of the optical absorption spectra between 1500 and 33,000 cm^{-1} as well as of the variation of the magnetic susceptibilities from 120 to 300°K, it is concluded that, in compounds of the type $M^{II}U_2^{V}F_{12} \cdot 4H_2O$ (M = Co,Ni,Cu), the site of the cation M^{2+} is octahedral with a weak ligand field, while U^{5+} is found in cubic symmetry, with coordination number 8, very probably deformed. (auth)

17610 STEPWISE FORMATION CONSTANTS OF COBALT(II), NICKEL(II), COPPER(II), ZINC(II), CADMIUM(II), AND URANYL-(II) COMPLEXES OF N-SALICYLIDENEANTHRANILIC ACID. Mehta, R. K.; Gupta, R. K. (Univ. of Jodhpur, India). Indian J. Chem.; 9: No. 10, 1150-1(Oct 1971).

Protonation constants of N-salicylideneanthranilic acid (H_2SA) and stability constants of its complexes with Co(II), Ni(II), Cu(II), Zn(II), Cd(II), and UO_2(II) were determined potentiometrically in 50% (vol/vol) dioxane $\mu = 0.1$ (sodium perchlorate) and temperature = 30° ± 0.1°C. The order of stability constants UO_2 > Cu > Ni > Co > Zn > Cd is in agreement with Irving and Williams rule. (auth)

Radioactive Waste Treatment

17611 (AEC-tr-7301) STUDY OF VITRIFICATION OF SOLUTIONS OF FISSION PRODUCTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by William J. Grimes from Section 11, pp 331-409 of report CEA-N-1419. 83p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 32041.

17612 (BNWL-1628) WASTE SOLIDIFICATION PROGRAM. VOLUME 9. POT SOLIDIFICATION PERFORMANCE DURING FINAL RADIOACTIVE TESTS IN WASTE SOLIDIFICATION ENGINEERING PROTOTYPES. McElroy, J. L.; Hartley, J. N.; Mendel, J. E.; Richardson, G. L. (Battelle Pacific Northwest Labs., Richland, Wash.). Jan 1972. Contract AT(45-1)-1830. 197p. Dep. NTIS.

Demonstration of solidification of high-level radioactive waste by the pot solidification processes was successfully completed. Approximately 4 million curies of radionuclides were processed and collected in 6- and 8-in.-dia containers during the final three engineering-scale runs in the Waste Solidification Engineering Prototypes (WSEP). The maximum self-generating heat rate density within an 8-in.-dia pot of solidified calcine was established at approximately 90 W/liter. The solidified calcine within a full 8-in.-dia pot represented 1.3 tonnes of power reactor fuel for PW-1 waste (irradiated to 20,000 MWd/tonne at a power level of 15 MW/tonne) and 0.74 tonnes in a 6-in.-dia pot for PW-4m waste (irradiated to 45,000 MWd/tonne at a power level of 30 MW/tonne). High-level aqueous radioactive waste was fed to the pot at average overall rates of 10 to 13.7 liters/hr. The equivalent processing rates ranged from 0.31 to 0.64 tonnes/day of original fuel. During one run the rising level glass process was demonstrated by solidifying PW-4m into a borosilicate glass. Approximately 10% of the total ruthenium fed to the solidifier was volatilized from the solidifier; entrainment of nonvolatiles was generally less than 1%. The WSEP auxiliary equipment, consisting of an evaporator, an acid fractionator, filters, and a caustic scrubber, reduced radionuclides in the stack gas to well below 10CFR20 release limits. The radionuclide content in the final liquid effluent was decontaminated by a factor of 10^9 for nonvolatiles and greater than 10^3 for radioruthenium to concentrations acceptable for recycle to a fuel reprocessing plant or low-level treatment processes. The sealed containers of radioactive solids are undergoing further testing in the Solids Storage Engineering Test Facility. (auth)

17613 (DPST-70-548) LOW-TEMPERATURE WASTE SOLIDIFICATION. Cordiner, J. B.; Hull, H. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan 1971. Contract AT(07-2)-1. 20p. Dep. NTIS.

The feasibility of converting aqueous radioactive wastes at the Savannah River Plant to water-free castable melts or manageable solids is assessed. A waste-melt process is proposed that incorpo-

rates desirable features from three one-step methods. The proposed scheme consists of a first-stage concentration from 30 to 60 wt % solids using a bent-tube evaporator, a second-stage concentration to 90 wt % solids using a wiped-film evaporator, and a third-stage concentration to a melt using an auger-agitated calciner or an additional wiped-film evaporator. A material-balanced flowsheet was developed that begins with aqueous wastes in storage tanks and ends with the filling of steel cylinders with melt for subsequent loading on railroad cars. Recommended heat-transfer areas and energy requirements are included. (auth)

17614 (FOA-4-4483) PRODUCTION IN PURE FORM OF AMERICIUM FROM WASTE SOLUTIONS FROM REPROCESSING OF PLUTONIUM. Halvarson, Kjell; Olausson, Birgit (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Dec 1971. 14p. (In Swedish). Dep. NTIS (U. S. Sales Only).

Separation and enrichment of small quantities of americium from solutions received from reprocessing of plutonium-bearing waste is described. Extraction, precipitation, and ion exchange techniques were used. Safety procedures were emphasized to keep the radiation dose of personnel at a low level. The preparations have been analyzed by tracer analysis. Spectrochemical analysis of americium preparations has shown a proportion of impurities of less than 1%. (Sweden)

17615 WASTE DISPOSAL EVAPORATOR FOR NUCLEAR POWER PLANT. Nakata, H. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan); Kuroda, S.; Imatake, T.; Matsubara, T.; Iwafuji, Y. Mitsubishi Juko Giho; 8: No. 5, 711-15(Sep 1971). (In Japanese).

Types of evaporators and decontamination methods employed for the disposal of waste liquids from nuclear power plants are described, centering around those being employed in various technical institutes. Mitsubishi Heavy Industries also has been conducting studies for practical application of such an evaporator, constructing a pilot plant with a stripping column for improving decontamination performance and increasing capacity. The results of the experiment have proved that the stripping column is very effective as a demister even for radioactive liquid which includes volatile matter. It is necessary to make positive efforts for developing chemical and mechanical defoaming methods. Various experiments on mechanical method including selection of defoamers and cleaning agents were carried out. (Japan)

17616 DECONTAMINATION OF RADIOACTIVE WATER WITH PEAT FILTERS. Bezzegh-Galantai, M.-M. (Birkhaeuser Verlag, Basel). Schweiz. Z. Hydrol.; 32: No. 1, 226-70(1970). (In German).

Percolation experiments were run in ion-exchange columns in the laboratory and in pilot-scale installations to determine the decontamination capacity of three types of peat dug in the Jura Mountains. Decontamination of water containing $^{90}Sr-^{90}Y$ was good. Retention of anionically available ^{131}I was measurable at extremely low concentrations ($<10^{-9}$ Mol NaI/liter; retention increased exponentially as dilution ratios increased) a solution of $<10^{-12}$ Mol Na ^{131}I/liter had a retained activity of from 60 to 90% relative to the inflowing solution. One of the findings of particular note is the correlation between the calcium content or degree of decomposition and the exchange or breakthrough capacity for cations. (Commercial Fisheries Abstr.)

Radioisotope Production

Refer also to abstract 17425.

17617 (INR-1283) PURIFICATION OF PALLADIUM TRACER AND SEPARATION OF CARRIER-FREE ^{111}Ag BY ANION EXCHANGE IN HYDROBROMIC ACID MEDIUM. Maleszewska, H.; Dybczynski, R. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 10p. INIS.

A convenient method for the separation of carrier-free ^{111}Ag from neutron-irradiated palladium target and recovery of radiochemically pure palladium tracer by anion exchange in hydrobromic acid plus bromine medium was devised. The yield of both silver and palladium tracers was practically 100% and high radiochemical purity was achieved. (auth)

17618 GENERATORS FOR THE PRODUCTION OF SHORT-LIVED RADIOISOTOPES. Spitsyn, V. I.; Mikheev, N. B. (Inst. of Physical Chemistry, Moscow). At. Energy Rev.; 9: No. 4, 787-842(Dec 1971).

The use of generators for short-lived radioisotopes for all groups of elements in the periodic system is reviewed. The theory of the operation of such generators and the principles underlying the structure of the corresponding isotope systems is given. It is shown that the generator technique provides one of the only practical ways in which isotopes with a short half-life can be made available; it enables them to be produced in a carrier-free form and with a high degree of chemical and radiochemical purity. Calculations are given which demonstrate the economic advantages of the generator technique. Progress in this field is hindered in some instances by the difficulty of producing the requisite amounts of parent isotope. (auth)

17619 PRODUCTION OF ^{103}Pd WITHOUT A CARRIER AND PREPARATION OF A RADIOACTIVE COLLOIDAL PREPARATION OF PALLADIUM FOR MEDICAL PURPOSES. Levin, V. I.; Kozlova, M. D.; Malinin, A. B.; Zalesskaya, A. B. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 637-42(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 622-7(Jul-Aug 1971).

Various methods of bringing cyclotron targets (plates) of metallic rhodium into solution were studied. The most rapid and effective method was electrolysis with alternating current in hydrochloric acid solution. The optimum conditions for dissolving rhodium by electrolysis were: hydrochloric acid concentration 6 N and current density ~1.25 A/cm^2. Under these conditions the rate of dissolution was about 50 mg/cm^2·h. The influence of various factors on the extraction of palladium by chloroform in the form of a complex with dimethylglyoxime was investigated. The influence of the concentration and nature of the acid in the aqueous solution, the concentration of dimethylglyoxime in the organic phase, the time of contact of the phases, the presence of rhodium, and the palladium concentration were investigated. The optimum conditions for the process of extraction were selected. A method based on registration of x radiation with an energy of ~20 keV and comparison with a standard source of ^{109}Cd was developed for measuring the activity of ^{103}Pd. The radioisotopic purity of the preparation was investigated. The total impurity of ^{103}Ru and ^{102}Rh did not exceed 5×10^{-3}% of the activity of ^{103}Pd. A method was developed for preparing a colloidal preparation of ^{103}Pd for use in radiotherapy. The preparation has a specific activity of 2.5 to 18 mCi/ml, contains 0.2 mg/ml palladium, and has pH = 4 to 6. The dispersion of a number of samples of a colloidal preparation of palladium was investigated on electron micrographs. No less than 80 to 85% of the colloidal particles of the preparation have dimensions lying in the range 3 to 7 mμ (the dimensions pertain only to the metallic portion of the micelle). Two variations of the method of determining an impurity of ionic forms of palladium in colloidal solutions, using paper chromatography and paper electrophoresis, were developed. The impurity of ionic forms of palladium in the preparation does not exceed 1%. (auth)

17620 ISOLATION OF ^{99}Mo FROM POWDERS OF IRRADIATED URANIUM DIOXIDE. Shiryaeva, L. V.; Tolmachev, Yu. M. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 619-25(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 603-10(Jul-Aug 1971).

The liberation of ^{99}Mo from irradiated samples of $UO_{2.0043}$, $UO_{2.0105}$, and $UO_{2.0124}$, heated under vacuum and in hydrogen, becomes appreciable at temperatures of 800°C and above. The activation energy of this process is equal to 58 ± 5 kcal/mole. In the calcination of the irradiated dioxide in oxygen, the liberation of ^{99}Mo proceeds at a high rate and at lower temperatures (≥400°C). A linear dependence of log D_0 for ^{99}Mo on the amount of excess oxygen in samples of uranium dioxide with a small deviation from the stoichiometric composition was found. The composition of chemical compounds, in which ^{99}Mo exists on the surface of irradiated uranium dioxide after it is heated under vacuum, depends on the amount of excess oxygen in the initial dioxide. The closer the uranium dioxide to the stoichiometric, the greater the probability of existence of ^{99}Mo in the form of lower relatively involatile oxides. (auth)

17621 ISOLATION OF ^{139}Ce WITHOUT A CARRIER FROM A TARGET: PREPARATION OF THE RADIATION SOURCE. Levin, V. I.; Tronova, I. N.; Shlyagin, K. N.; Savel'ev, G. I. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 633-6(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 618-22(Jul-Aug 1971).

Optimum conditions for separation of microquantities of cerium from macroquantities of lanthanum with the aid of extraction chromatography on a column filled with granulated Teflon, coated with a film of bis(2-ethylhexyl) phosphate, were selected. Oxidation with bromate in 6 M nitric acid was used to convert cerium to the tetravalent state. The cerium was eluted with 4 M hydrochloric acid, containing 10% hydrogen peroxide. Cerium-139 was isolated without a carrier by the method described from a lanthanum-target irradiated on a cyclotron. Preparations of ^{139}Ce were obtained

with a yield close to 100%. The electron, x and γ spectra of the ^{138}Ce preparations were investigated. The absence of radioisotopic impurities was demonstrated with a sensitivity of measurement corresponding to 0.1% of the activity of ^{139}Ce. A radiation source was prepared from ^{139}Ce with an activity of ~6 mCi (by absorption of the isotope in an ion exchange film). (auth)

17622 PREPARATION OF SOURCES FOR γ-FLAW DETECTION ON THE BASIS OF THE RADIOACTIVE ISOTOPE ^{54}Mn. Danilin, L. D.; Pavlova-Verevkina, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 643-6(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 627-30(Jul-Aug 1971).

A method was developed and the purification of radioactive waste products from the production of ^{55}Fe was performed in order to produce a radiochemically and technically pure solution of ^{54}Mn for the preparation of a γ source. The purification was carried out by extracting a diethyldithiocarbamate complex of Mn in chloroform, followed by reextraction of Mn with 2.5N HCl. A method was developed for preparation of a γ source based on ^{54}Mn, consisting of sorption of manganese on a strongly acid cation exchange resin with small grain size from a 0.1N solution of HCl. A γ source based on ^{54}Mn for flaw detection was prepared. The emitting portion of the source has a dimension d = 1.2 mm, h = 2 mm. The activity of the source is 7 mCi. (auth)

17623 GENERATOR OF ^{99m}Tc. Mikheev, N. B.; Volkova, N. L.; Rumer, I. A.; Popovich, V. B.; Bazhenova, T. L. Sov. Radiochem. (Engl. Transl.); 13: No. 4, 647-9(Jul-Aug 1971).

Translated from Radiokhimiya; 13: No. 4, 631-3(Jul-Aug 1971).

A method was developed for production of a generator of ^{99m}Tc from irradiated molybdenum, based on the adsorption of molybdenum by aluminum oxide in the form of phosphomolybdate. It was established that the radioisotopic purity of ^{99m}Tc, obtained from the generator, is no lower than 99.99%, while the content of Tc in the form of pertechnetate is no less than 99%. (auth)

17624 CYCLOTRON PRODUCTION OF CARRIER-FREE ^{111}In. Brown, L. C.; Beets, A. L. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop.; 23: No. 2, 57-63(Feb 1972).

Carrier-free ^{111}In was developed as a long-lived complement with identical chemistry to the short-lived ^{113m}In which has been used extensively in nuclear medicine for labeling and in vivo distribution studies. This radionuclide was produced in 200 to 300 mCi amounts in the ORNL 86-in. cyclotron under conditions obtainable with commercial cyclotrons. Production yields, a chemical-separation procedure, and a target-recovery procedure for production of ^{111}In from enriched ^{111}CdO targets are presented. (auth)

17625 PURIFICATION OF ^{227}Ac BY CATION EXCHANGE. Nastasi, Maria Jose C.; Dominguez, G. (Junta de Energia Nuclear, Madrid). An. Quim.; 66: No. 7-8, 661-8(1970). (In Spanish). (IEA-229).

Actinium-227 can be purified by a cation exchange method that is suitable either to provide this nuclide pure enough for the determination of its α-spectrum, or to purify it continuously in a resin column coupled to a γ detector. This last possibility opens the way to the detection of its γ spectrum free of the interference of its radioactive daughters. Commercially available actinium is fixed on a cation resin bed, and all its daughters but thorium-227 are eluted with 8.5N $HClO_4$-0.5N HCl; then, actinium is eluted in a rather sharp band with 6N HNO_3. Although a very sharp band of thorium-227 comes out of the column before that of actinium, a good separation of both can be achieved. Finally, the remaining thorium activity is eluted with 7% $H_2C_2O_4$. Thorium-free actinium may be loaded again on a resin bed and continuously purified from fast-growing francium and radium-223 by washing with 8.5N $HClO_4$-0.5N HCl. No explanation is found for the untimely partial elution of thorium-227 on the ground of its experimentally determined K_d values in $HClO_4$-HNO_3 mixtures. (auth)

17626 PRACTICAL PROBLEMS IN THE SELECTION OF GENERATORS AND RADIOPHARMACEUTICALS. Touya, J. J. Jr.; Bonomi, J. C.; Ferrando, R.; Touya, E. (Facultad de Medicina, Montevideo). pp 15-28 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

The factors governing the choice between ^{99m}Tc and ^{113m}In radiopharmaceuticals in a nuclear medicine laboratory are reviewed. The relative technical merits of ^{99m}Tc and ^{113m}In radiopharmaceuticals for specific diagnostic procedures are discussed. Data relating to the relative costs of services based on the use of ^{99m}Tc and ^{113m}In radiopharmaceuticals are presented. The use of ^{113m}In radiopharmaceuticals is shown to offer both technical and economic advantages, though the stationary-detector scintigraphic devices in current use give better spatial resolution when used in conjunction with ^{99m}Tc radiopharmaceuticals. (auth)

17627 TESTS FOR ELUTION AND ELUATES FROM ^{113m}In GENERATORS. Robles, Ana Maria; Servian, J. L.; Touya, J. J. Jr. (Facultad de Medicina, Montevideo. Facultad de Quimica y Farmacia, Montevideo). pp 91-5 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971)

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

A study of the elution processes recommended by the manufacturers of three different ^{113m}In generators was carried out in an attempt to determine the influence of factors such as normality and temperature of the eluent and rate of elution on the elution curve. Small modifications in the conditions of elution failed to affect the elution curve. Contamination of the eluates with ^{113}Sn and other radionuclidic impurities, as well with Zr, was also studied. Experiments were carried out to determine the extent of ^{113m}In adsorption on glassware and the effect of treatment with silicone on it. (auth)

17628 PREPARATION AND CONTROL OF ^{87m}Sr RADIOPHARMACEUTICALS. Trott, N. G.; Popham, Mary G. (Royal Marsden Hospital and Inst. of Cancer Research, Sutton Eng.). pp 105-9 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

Two main types of generator system are briefly described. In one of these, strontium-87m is milked from the yttrium-87m generator using a dilute solution of citric acid. After correction of pH this eluate can then be sterilized and is ready for injection. In the other type of generator the eluate has to be first evaporated to dryness and then taken up in saline. Possible impurities in the eluted ^{87m}Sr are discussed, the most important being ^{88}Y, which has a half-life of 108 days. However, the quantity eluted from a fresh generator is stated to be less than 0.01 μCi per mCi ^{87m}Sr. The nuclide can be assayed using a calibrated ionization chamber. Published calibration data give the total internal conversion coefficient of the 388-keV γ ray as 0.212 ± 0.002 and the half-life as 2.805 ± 0.003 h. Strontium-87m can also be produced by slow neutron irradiation of enriched ^{86}Sr and some applications of the material produced in this material have been reported. (auth)

17629 PREPARATION AND CONTROL OF ^{132}I RADIOPHARMACEUTICALS. Ganatra, R. D. (Bhabha Atomic Research Centre, Bombay). pp 111-16 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

The development of the ^{132}Te-^{132}I generator system and its current versions are described. The advantages and disadvantages of ^{132}I-iodide as an agent for thyroid function tests are reviewed. Its main advantage is the low radiation dose to the patient inherent in its use. On the other hand, its short half-life renders it unsuitable for long-term studies, while the high energy of its γ rays makes it unsuitable for scintigraphy. Other applications of ^{132}I radiopharmaceuticals are briefly discussed. (auth)

17630 PREPARATION AND CONTROL OF ^{137m}Ba RADIOPHARMACEUTICALS. Castronovo, F. P. Jr.; Wagner, H. N. Jr. (Johns Hopkins Medical Institutions, Baltimore). pp 127-35 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

Recent progress in the preparation and control of ^{137m}Ba-radiopharmaceuticals is reviewed. Emphasis is placed on the advantages and disadvantages of the ^{137m}Ba-radionuclide, the development of the generator system and the quality control pertaining to the final product. Biological studies after a constant infusion of ^{137m}Ba-EDTA and after a bolus injection of ^{137m}Ba-chloride are outlined. (auth)

17631 PREPARATION AND CONTROL OF ^{103m}Rh RADIOPHARMACEUTICALS. Lengyel, T. (Inst. of Isotopes, Budapest). pp 137-43 of Radiopharmaceuticals from Generator-Produced

Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). Ses STI/PUB-294; CONF-700517.

After a review of the general features of isotope generators, the preparation of the ^{103}Pd-^{103m}Rh generator is briefly discussed. A survey of suitable compounds prepared from the ^{103m}Rh generator is given, emphasizing the biological aspects of their use. The main steps of quality control from the chemical, radiochemical, and pharmaceutical points of view are concisely considered. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 17449, 17450, 17454, 17692, 17693, and 17758.

17632 (AED-CONF-71-100-22) DEVELOPMENT OF REPROCESSING METHODS FOR HTGR-FUELS. Schaefer, L.; Wojtech, B. (Farbwerke Hoechst, Frankfurt am Main (West Germany)); Kaiser, G.; Merz, E.; Sckuhr, P. (Kernforschungsanlage, Juelich (West Germany)). May 1971. 16p. (CONF-710901-523). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Aqueous reprocessing methods were investigated for their applicability for recovering thorium and uranium from high-burnup HTGR fuels. The head-end steps, the flowsheets worked out, and the decontamination factors obtained are discussed. A pilot plant is proposed and described. (M.C.G.)

17633 (CEA-CONF-1878) RECOVERY OF TRANSURANIC ELEMENTS IN NUCLEAR FUELS. ([Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires]). 16 Apr 1971. 10p. (In French). (CONF-710444-7). Dep. NTIS (U. S. Sales Only).

From International conference on chemical sciences; Paris, France (20 Apr 1971).

The methods used by the CEA for recovering Np and Am are presented. The behavior of these isotopes during the reprocessing of irradiated fuels is described. The results obtained after a preliminary recovery trial in the pilot irradiated fuel reprocessing plant at Marcoule using solutions obtained by reprocessing of the irradiated Pu alloy are presented. The Np recovery system has been developed and is functioning. Current work on the separation and purification of Am and Cm is described. (France)

17634 (DOCKET-50201-108) WEST VALLEY REPROCESSING PLANT. Monthly Status Report on Low Level Waste Treatment Facility. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 14 Feb 1972. 24p. Dep. NTIS.

Latest plant performance and the current status of the development program for the Low-Level Liquid Waste Treatment Facility are summarized. All discharges from lagoons 4 and 5 were below 2×10^{-5} μCi ^{137}Cs/ml. Resin usage is shown. ^{137}Cs, ^{90}Sr, ^{106}Ru, ^{106}Rh, and gross β removal factors are listed. (M.C.G.)

17635 (ORNL-TM-3257) ENGINEERING DEVELOPMENT STUDIES FOR MOLTEN-SALT BREEDER REACTOR PROCESSING NO. 7. McNeese, L. E. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 92p. Dep. NTIS.

Calculations were made to identify important operating parameters in the fluorination-reductive extraction and metal transfer flowsheet. Design calculations were made for induction heating of a frozen-wall fluorinator. The first engineering experiment for studying removal of rare earths from single-fluid MSBR fuel salt by the metal transfer process was completed. Studies were also made on purification of salt by continuous methods, semicontinuous reductive extraction experiments in a mild steel facility, and axial dispersion coefficients in packed columns. (M.C.G.)

17636 EQUIPMENT FOR PREPARING URANOUS NITRATE. Auchapt, Pierre; Croix, Jacques; Cuq, Andre; Dufour, Jean; Marcon, Gabriel (to Commissariat a l'Energie Atomique). French Patent 2,065,652. 6 Aug 1971. Filed 30 Oct 1969. (In French).

Uranous nitrate is used as a reducing agent for Pu in the separation of Pu and U, recovered from irradiated nuclear fuel elements by liquid-liquid extraction. A process for preparing uranous nitrate by electrolytic reduction of uranyl nitrate is presented, and a description given of the electrolysis equipment. A solution of uranyl nitrate is continuously fed into one end of an elongated electrolyzer. This solution is circulated between two parallel electrodes (Pt anode and Hg cathode). The cathode Hg is made to circulate continuously and longitudinally in the electrolyzer, preferably in the same direction as the nitrate solution. The uranous nitrate is obtained at the other end of the electrolyzer. (France)

17637 PROCEDURE FOR RE-EXTRACTING METALLIC ELEMENTS FROM AN ORGANIC SOLVENT. Ravenel-Maury, Jacques; Soret, Christian (to Commissariat a l'Energie Atomique). French Patent 2,064,592. 28 Jun 1971. Filed 1 Oct 1969. (In French).

A procedure for re-extracting metallic elements from an organic solvent (nonmiscible with water) is described, the procedure being applicable to U contained in an organic phase. A solvent miscible with water and the organic solvent is added to the organic solvent containing the U to be separated. The resulting solution is passed through a resin ion exchanger. An alcohol is used when extracting U from tributyl phosphate and a heterocyclic compound is used when extracting U from tridodecylamine. The alcohol used may be methanol, ethanol, or n-propanol; pyridine is the heterocyclic compound used. The acidity of the solution is adjusted before passage through the resin ion exchanger. (France)

17638 MECHANISM OF EXTRACTION OF URANYL NITRATE BY ORGANOPHOSPHORIC ACIDS FROM NITRIC ACID SOLUTIONS. Rozen, A. M.; Martynov, B. V.; Anikin, V. I. Dokl. Akad. Nauk SSSR; 199: No. 4, 838-41(1 Aug 1971). (In Russian).

The mechanism for the extraction of $UO_2(NO_3)_2$ by bis(2-ethylhexyl) phosphate (DEHPA) over a wide range of acidities is discussed. The original solutions contained 4.25 and 1.6 g U/l in HNO_3 (2 to 9 M), with and without $LiNO_3$, $NaNO_3$, and NH_4NO_3 as salting out agents. The extractant was 0.195 M DEHPA in CCl_4. The logarithm of the distribution coefficient was a linear function of log [DEHPA], and practically linear functions of log $[NO_3^-]$ and log $[H^+]$, respectively. The effective equilibrium constant was approximately 1.3×10^{-4} over the range of nitric acid concentrations studied. (K.S.W.)

17639 LANTHANIDE-ACTINIDE SEPARATION BY COUNTERCURRENT ELECTROLYTES. Bilal, B. A.; Reichmuth, C. (Hahn-Meitner Institut, Berlin). J. Inorg. Nucl. Chem.; 34: No. 1, 348-9(Jan 1972). (In German).

Arising from the interest in separating transuranium elements and fission products from spent reactor fuels and the desirability of a single-stage process, Am^{3+} and Nd^{3+} taken as representatives of the actinide and lanthanide groups and having the same charge and almost the same ionic radius, were separated by countercurrent electrolysis of their aqueous nitrate solutions. The solutions were added to a constant flow of 2N acetic acid passing through a separation column 50m long, packed with nylon gauze, under an applied voltage of 2500 V, The current being maintained at 90mA. Outside the Am/Nd overlap region good separation was achieved after 20 h, neither component being contaminated by the other within the detection limit (1 ppM) of the measurement apparatus employed. (UK)

17640 OXIDE DISSOLUTION MECHANISMS. II. A MECHANISM FOR THE THORIA/NITRIC/HYDROFLUORIC ACID SYSTEM. Shying, M. E. (Australian Atomic Energy Commission, Sutherland); Florence, T. M.; Carswell, D. J. J. Inorg. Nucl. Chem.; 34: No. 1, 213-20(Jan 1972).

Proton activity and temperature were studied in an attempt to elucidate the dissolution mechanism of thoria in nitric-hydrofluoric acid solution. The results indicate that the order of reaction with respect to proton activity is two and the apparent energy of activation is 18 kcal/mole. A dissolution mechanism consistent with the experimental data is suggested and the steps involved in the reaction are discussed. (auth)

ENGINEERING

17641 (STI/DOC-11(Vol.9)(No.3)) LIST OF BIBLIOGRAPHIES ON NUCLEAR ENERGY. (International Atomic Energy Agency, Vienna (Austria)). Dec 1971. 30p.

A list is presented of 110 bibliographies, published or in preparation on nuclear energy. The entries are classified by subject following the pattern adopted for the IAEA publication "Atomindex". (L.C.L.)

Energy Conversion

Refer also to abstracts 18379, 19466, and 19724.

17642 (AED-C-12-25) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 12. NUCLEAR SCIENCE LITERATURE OF EASTERN COUNTRIES. NUMBER 25. THERMIONICS. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct 1971. 29p. (In German and English). Dep. NTIS (U. S. Sales Only).

A bibliography of 217 items from East European literature published between Jan. 1968 and Mar. 1971 in the field of thermionics is presented. The bibliography notations are in English. The language of the text is indicated. An author index is included. (L.C.L.)

17643 (AED-CONF-71-100-18) APPLICATION OF NUCLEAR PROCESS HEAT FOR PROCESS TECHNIQUES. Schulten, R.; Kugeler, K.; Hansen, U.; Teuchert, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung); Cautius, W. (Arbeitsgemeinschaft Versuchs-Reaktor G.m.b.H., Duesseldorf (West Germany)). May 1971. 18p. (CONF-710901-522). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of high-temperature reactors showed encouraging results in areas of contamination control and safety, so that an introduction of the high-temperature reactor into the general energy market appears feasible. These results show that low-cost nuclear reactor heat can be offered at temperatures up to 950°C and in the future to 1200°C. This will be reached by development of the once-through concept of the pebble-bed reactor. The fuel balls are continuously loaded at the top of the core under full power condition. They move slowly down to the bottom and reach their final burn-up during this irradiation period. In the upper part of the core, the fresh fuel yields a high power density, but the downward flow of cooling gas prevents the fuel temperature exceeding the design limits. In the lower core region there is only a moderate heat transfer to the coolant because of fuel depletion. The once-through pebble-system allows an increase in the average gas outlet-temperature to 950°C and higher. It is characterized by simplicity and flexibility in core layout and fuel cycle optimization. In the lower temperature region, such atomic power plants are able to produce steam and electricity; in the upper temperature region they are adapted for direct heat application. Processes which will be in question in the near future are discussed. These include production of superheated steam for chemical industries and refinery plants, production of hydrogen from natural gas and petrol, processing of heavy crude oil to hydrogen and to light hydrocarbons, production of olefins from petrol, and gasification of coal. (auth)

17644 (GEMS-3526-1) PRELIMINARY DESIGN AND SAFETY STUDIES OF LARGE RADIOISOTOPE HEAT SOURCES FOR SPACE POWER. Mid-Term Technical Progress Report, April 15, 1965–July 31, 1965. Serkiz, A. W. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contract AT(30-1)-3526. 286p. (65-SD-4408). Dep. NTIS.

From April to August 1965 design and safety studies were conducted of heat source subsystems for ^{244}Cm, ^{210}Po, and ^{238}Pu fuels to be used in conjunction with thermoelectric, Brayton, or Rankine power conversion subsystems in order to develop safe and reliable power supplies for manned and unmanned space missions requiring 1 to 10 kW(e). The initial study results included: establishment of general safety criteria; review of potential applications and missions to provide design requirements; design analysis of cylindrical heat sources in vented and unvented capsules; and review of data on the properties of heat source and cladding materials. (L.C.L.)

17645 (GEMS-3526-1(Vol.3)) PRELIMINARY DESIGN AND SAFETY STUDIES OF LARGE RADIOISOTOPE HEAT SOURCES FOR SPACE POWER. VOLUME III. DEVELOPMENT PROGRAM. [Final Report], April 15, 1965–October 15, 1965. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 24 Jan 1966. Contract AT(30-1)-3526. 172p. (65-SD-4508-3A). Dep. NTIS.

A program for implementing development of large radioisotope heat sources for use with power conversion systems for space missions is described in detail. Thirteen separate tasks are designated. The objectives, problem areas, and time schedule for each task are discussed. (L.C.L.)

17646 (GEMS-3526-2(Vol.2)) PRELIMINARY DESIGN AND SAFETY STUDIES OF LARGE RADIOISOTOPE HEAT SOURCES FOR SPACE POWER. VOLUME II. MISSION FACTORS AND SUPPLEMENTAL TECHNICAL INFORMATION. Final Technical Progress Report, April 15, 1965–October 15, 1965. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contract AT(30-1)-3526. 395p. (65-SD-4508-2A). Dep. NTIS.

Potential missions of space vehicles containing radioisotope-fueled auxiliary power systems can be classified as manned or unmanned, each of which imposes significantly different requirements on the heat source. A review of the mission and system requirements was made to determine which set of requirements, manned or unmanned, would be most restrictive and therefore limiting to the heat source design. The following were studied: shielding requirements for ^{244}Cm, ^{238}Pu, and ^{210}Po heat sources; power system analysis; power system competitiveness; fuel recovery from manned and unmanned flights; and concepts for on-ground, in-space, and lunar-surface handling of fuel. It was concluded that manned missions place the more restrictive demands on the heat source design. Early requirements call for utilization of a short half-life isotope, with eventual utilization of the longer half-life fuels. (L.C.L.)

17647 (GEMS-3526-3) LARGE RADIOISOTOPE-COMPACT CONVERTER POWER SYSTEM STUDY. Final Report, April 15, 1966–June 30, 1966. Keiser, J. T. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 25 Oct 1966. Contract AT(30-1)-3526. 208p. (66-SD-4472-A). Dep. NTIS.

Results are given of a study which was performed to combine the results of continuing AEC contract efforts on large radioisotope heat sources and on compact thermoelectric converters in order to evaluate the mutual compatibility of these components for use on space missions and to provide information for further radioisotope thermoelectric power systems development. Radioisotope thermoelectric power systems in the 1 to 5 kW(e) range using ^{210}Po with silicon-germanium and lead-tellurium couples and ^{238}Pu with silicon-germanium and lead-tellurium couples were investigated. Specific power system designs considering the factors of vehicle integration were prepared for 2 kW(e) systems suitable for use in the Apollo Applications Program. (L.C.L.)

17648 (GEMS-NS-102) SNAP-17B POWER SUPPLY DEVELOPMENT PROGRAM (PHASE I). Final Report. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 15 December 1964. Contract AT(30-1)-3308. 352p. (64-SD-875). Dep. NTIS.

Phase I of the SNAP-17B Power Supply Development Program was undertaken to demonstrate the overall feasibility of the strontium-90-fueled thermoelectric generator power supply system and its associated ground handling equipment. This phase included the preliminary designs and analyses of all major equipment and testing of selected components. Design of the systems components was sufficiently completed to permit fabrication of development test units for Phase II. Detailed design data of the SNAP-17B system are presented. (L.C.L.)

17649 (GEMS-NS-102(App.A)) SNAP-17B POWER SUPPLY DEVELOPMENT PROGRAM (PHASE I). APPENDIX A. SPECIFICATIONS. Final Report. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 15 December 1964. Contract AT(30-1)-3308. 170p. (64-SD-876). Dep. NTIS.

The preliminary design criteria for the SNAP-17B system, i.e., the SNAP-17B space power supply and its associated ground handling equipment, are defined. SNAP-17B is a ^{90}Sr-fueled thermoelectric generator capable of continuously supplying 25W of dc power at 28V for 5 y in an earth-orbiting communications satellite. Design criteria are given for: power characteristics; load characteristics; configuration; fuel form; ground handling system; instrumentation; safety; design and construction; quality assurance; and preparation for shipment. (L.C.L.)

17650 (GEMS-NS-105) PRELIMINARY DESIGN AND ANALYSIS OF 100-WATT RADIOISOTOPE THERMOELECTRIC GENERATOR. Final Technical Report. (General Electric Co.,

Philadelphia, Pa. Missile and Space Div.). 15 Aug 1964. Contract AT(30-1)-3308. 162p. (64-SD-899). Dep. NTIS.

The preliminary design and analysis of 100W ^{90}Sr-fueled thermoelectric generators for two year space missions are resented. The problems of integrating four 100W RTG's with a single Atlas–Agena launched satellite system are defined. The fuel handling equipment required and the integration of an on-pad fuel loading system were evaluated. Safety requirements and their effects on the RTG design were investigated. Program plans for developing the 100W RTG were prepared. (L.C.L.)

17651 (ORNL-tr-2558) CORRELATION OF OUTPUT PARAMETERS OF RADIOISOTOPIC THERMOELECTRIC GENERATORS (IZOTEGs) WITH LOAD. Malyshev, A. Ya.; Ragozinskii, A. I.; Korotkov, N. P.; Dmitriev, A. I.; Sapelkin, B. P. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Radiats. Tekh.; No. 6, 158-63(1971). 5p. Dep. NTIS.

Results are presented of long-term tests on 8 different radioisotope-fueled thermoelectric generators developed in the USSR. The tests were performed to determine the effects of load on the output characteristics of the generators. It is concluded that for maximum efficiency, energy from the thermoelectric generators should be used directly, i.e., without the use of output voltage transformers. (L.C.L.)

17652 (ORNL-tr-2559) DEPENDABILITY OF RADIOISOTOPIC THERMOELECTRIC GENERATORS. Korotkov, N. P.; Dmitriev, A. I.; Malyshev, A. Ya.; Sapelkin, B. P. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Radiats. Tekh.; No. 6, 163-6(1971). 3p. Dep. NTIS.

The development of radioisotope thermoelectric generators in the USSR is reviewed with information on the design, construction, life testing, and operation at remote terrestrial sites such as Antarctica and high-mountain meteorology stations. The heat sources used were ^{144}Ce and ^{90}Sr. (L.C.L.)

17653 ONE-DIMENSIONAL STUDY OF FARADAY MPD GENERATOR WITH HALL EFFECT. Bartl, Josef; Morawitz, Rudolf (Technical Univ., Brno). Elektrotech. Cas.; 22: No. 10, 709-23(1971).

An analysis is made of the influence of the Hall effect on the characteristics of a dc linear Faraday-type MPD-generator with segmented electrodes, working in an open circuit with combustion products under the conditions of a constant Mach number with a thermal input of 1 MW and 2000 MW. The system of equations describing the MPD-generators work respects apart from the Hall effect also the influence of further losses such as those incurred by cooling of channel walls and losses caused by friction. In the calculation of the MPD-generator characteristics the dependence of low-temperature plasma transport properties on the thermodynamic flow parameters was considered. The results of variant calculations (the task was solved by the aid of the digital computer Minsk 22), which are presented mainly as diagrams, are partially compared with data published by others. (auth)

17654 MHD POWER GENERATION: STATE OF THE ART AND PROSPECTS FOR ADVANCED NUCLEAR APPLICATIONS. Rosa, Richard J. (AVCO Everett Research Lab.). pp 315-26 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

State-of-the-art developments in magnetohydrodynamic power generation are reviewed. Base load, emergency, and peaking power generation are included. Economic and environmental factors are considered in relation to MHD generator location. Applications of MHD generators in radiating power plants, propellant-cooled propulsion systems, and commercial industries are cited. (auth)

17655 PERFORMANCE OF HELIUM SEEDED WITH URANIUM IN A MAGNETOHYDRODYNAMIC GENERATOR. Bishop, Allan R. (NASA Lewis Research Center). pp 335-41 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The feasibility of using helium seeded with uranium as a working fluid in an MHD generator is discussed. Nonequilibrium ionization of the seed (uranium), including losses due to electrothermal instabilities, is examined over a range of stagnation temperatures (2000 to 4000°K), stagnation pressures (10 to 50 atm), and Mach numbers (0.5 to 1.5). The optimum mixture (for maximum power density) of helium and uranium is about 6 atoms of uranium/1,000 atoms of helium. The nonequilibrium conductivity, including instability losses, is higher than the equilibrium conductivity for the temperature range considered. The output power of a specific generator configuration is presented as a function of stagnation temperature. The helium-uranium mixture is a possible working fluid for MHD generators, although the power density is lower than those for more conventional working fluids. (auth)

17656 INVESTIGATION OF NONSTATIONARY FLOWS IN A MAGNETOHYDRODYNAMIC GENERATOR CHANNEL. Alavidze, G. R.; Paskonov, V. M. Sb. Rab. Vychisl. Tsent. Mosk. Gos. Univ.; No. 15, 103-9(Apr 1971). (In Russian).

Nonstationary subsonic flow of an ideal inviscid electrically conductive gas is theoretically analyzed in an infinitely subdivided channel of constant cross section in a magnetohydrodynamic power generator. The nonlinear gasdynamic equations are solved by the method of finite differences simultaneously with the equation for the current in the external electric circuit including resistance and inductance. It was found as a result of the calculations that effects due to unsteadiness of processes in the MHD generator are appreciable. Thus a transition from no-load to power generating conditions leads to development of temporary gas-heating regions in the channel. A rapid increase in stagnation pressure at the input to the channel causes considerable gradients of the electrode potential and hydrodynamic parameters. The inductance in the external circuit causes aperiodic damped oscillations of gasdynamic and electrical parameters. Increasing this inductance increases the time of transient processes and the amplitude of the oscillations. (JPRS)

17657 IMPROVEMENTS IN OR RELATING TO NUCLEAR POWERED ELECTRICAL ENERGY SOURCES. (to General Alarm Corp.). British Patent 1,256,642. 8 Dec 1971. Priority date 27 Mar 1968, United States.

The energy source incorporates a photovoltaic substance responsive to light to serve as the voltage generator. A source of nuclear radiation is also included, the energy of which is converted to light by phosphors. The light is in turn converted to electricity by the photovoltaic substance. (J.R.D.)

Facilities and Equipment

Refer also to abstracts 17915, 18115, 18126, 18369, 18381, and 19640.

17658 (AI-AEC-13022) EXPERIMENTAL EVALUATION OF A SODIUM FREEZE VENT SYSTEM. Eichelberger, R. L.; McKisson, R. L. (Atomics International, Canoga Park, Calif.). 31 Jan 1972. Contract AT(04-3)-824. 32p. Dep. NTIS.

Two sodium freeze vents, designed in conformance with the Design Appendix of RDT E 4-13T, were tested over several ranges of temperature and sodium flow rate. Both vents were 27.5 in. long, and had annular widths of 0.055 in. between the outside of the internal heater and the ID of the outer pipe. In one vent, the pipe was provided with horizontal fins; in the other, the fins were omitted. With a vent temperature of 90°F, frozen sodium seals were successfully made with sodium velocity in the vent up to 30 ft/s. For a given sodium flow rate, the seal location in the vent is most strongly influenced by vent temperature. Application of 500-psi pressure on the sodium side of the seal did not cause creep in the vent. Also, in limited tests, in which oxygen contaminants were added both to the sodium and gas sides of a freeze seal, there was no effect on the ease of seal melting. Raising the sodium temperature did result in an upward movement of the frozen plug when the seal was initially formed near the bottom of the vent. The motion occurred over an interval of a few milliseconds, at which time the seal reformed. For optimum stability, seals should be formed in the upper half of a freeze vent. As a further precaution against seal failure, the gas space above the seal should be small and closed. Results of the work were used as a basis of recommendations for improving the RDT Standard. (auth)

17659 (CEA-CONF-1882) SPITFIRE LOOP. Colomez, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 19 May 1971. 9p. (In French). (CONF-710628-5). Dep. NTIS (U. S. Sales Only).

From Euratom conference on radiation devices; Cadarache, France (10 Jun 1971).

The Spitfire loop, intended for irradiating in Osiris, high-temperature reactor fuel elements under in-pile conditions (purified He, and high temperatures) is described. The irradiation can be effected, either in the core (fast and thermal neu-

trons) or outside the reactor vessel, if the appropriate means are used (e.g., thermal neutrons cycling). The neutron flux within the core is of the order of 2.10^{14} n cm^{-2} s^{-1} (thermal or with E > 1 MeV). The loop is of the central injector type; it does not have any moving parts in its in-pile component. The materials requiring maintenance are assembled out-of-pile. After irradiation, the fission product deposits released by the fuel element are retained by the walls of an exchange recuperator at 750 to 150°C to be studied. (France)

17660 (CEA-CONF-1884) USE OF THE COLIBRI DEVICE FOR HIGH-TEMPERATURE IRRADIATIONS. Bauchede, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1971. 14p. (In French). (CONF-710628-4). Dep. NTIS (U. S. Sales Only).

From Euratom conference on radiation devices; Cadarache, France (10 Jun 1971).

The Colibri device was designed for irradiating materials at high temperatures (200 to 800°C) in the core of Osiris. The standard version consists of two 316 stainless steel containers, placed one in the other. For irradiations with high temperature reactors, a second part is connected to the flexible standard part. The form of this part is identical to that currently used for the high temperature thermocouple compensation leads; its utilization is envisaged for all the supplementary instrumentation. The different modifications brought about to the standard model (purification of the injected gas, measurement of fission products, control of the cleanliness of the gas sample, and dose measurements) allow a temperature of 1250°C to be reached. (France)

17661 (EUR-4692) STUDY OF THE LEVEL REGULATING SYSTEM OF A SHIP'S STEAM GENERATOR. Basile, F.; Merino, R.; Selvaggi, G. (European Atomic Energy Community. Fiat, Turin (Italy). Sezione Energia Nucleare. Ansaldo S.p.A., Genoa (Italy)). 1971. 79p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR Lit. 1,560.

The results are presented of a study relating to the design of a steam generator capable of a good performance even when subject to wave motion. After a short general description of the standards developed and used for defining stationary and transient operating conditions, the following main points are discussed: research on the thermohydraulic stability of the recycling circuit with and without the effects of wave motion; determination of the stationary operating characteristics; and transient behavior of the steam generator and characteristics of the level regulating system. The calculation method employed for analyzing the transients enables the primary and secondary circuits to be simulated at the same time. By including the simulation of the level regulating system together with the feedwater circuit and the corresponding optimization of the control valve it was possible to undertake a study of the level control system, its components and the set points of the electronic equipment, taking into account the effect of the vessel's motion on the chief control signals. A type of loading ramp was used as an external disturbance for analyzing the transients. (auth)

17662 (EUR-4737) BR2 IRRADIATION DEVICES FOR HTGR FUEL. von der Hardt, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Dec 1971. 60p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 85.-.

A general survey of BR2 fuel irradiations for high-temperature gas-cooled reactors is given. A universal capsule-type irradiation device (rig) is also described, together with its fission product sweep loop. Calculation methods, and results, for the thermal characteristics of the rig and for radioactive isotope transport are explained. (auth)

17663 (K-D-1951) VTE TUBE BUNDLE COMPONENT STUDY FOR DESALINATION PROGRAM. Gregory, J. W. (Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.). Mar 1967. Contract W-7405-eng-26. 46p. Dep. NTIS.

Preliminary design studies for the development of processes for desalination of seawater have shown that the vertical tube evaporator (VTE) concept presents many favorable aspects. In this type evaporator, the tube bundles represent approximately 30% of the total capital cost, and as such are the largest single cost item. A component study to determine the materials, methods, and dimensions that will provide a satisfactory, low cost bundle is presented. (T.F.D.)

17664 (RD/B/N-2071) CONTROLLED HELIUM ATMOSPHERE PLANT (CHAP). Hughes, G.; Jackson, J. H. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Oct 1971. 39p. (RPC/ISG-71-P-30). Dep. NTIS (U. S. Sales Only).

It is considered that the deposition of active atomic species on components within the gas circuit of a Mk. III high-temperature reactor will depend on impurities in the helium coolant arising from water inleakage and the resulting reactions in the core. In order to investigate this effect, a Controlled Helium Atmosphere Plant (CHAP) was designed and constructed to provide helium containing closely controlled amounts of the impurities H_2, H_2O, and CO in the approximate concentration range 0.01 to 10 vpM. It was designed to accommodate two experimental phases, phase I in which the helium flow rate is a function of the water vapor concentration (the laminar flow condition) and phase II in which studies are made in simulated reactor conditions (fast flowing). The design and construction of CHAP are described and the performance of the system analysed. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 17643, 18381, 19700, and 19835–19840.

17665 (KFK-1482) RESULTS OF HEAT TRANSFER AND PRESSURE LOSS MEASUREMENTS WITH HELIUM IN A TUBE BUNDLE. Marek, J.; Maubach, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Sep 1971. 60p. (In German). Dep. NTIS (U. S. Sales Only).

Results are reported of measurements performed with respect to pressure drop and heat transfer of helium at a pressure of 40 atm flowing through a bundle of 9 tubes in a square arrangement. The tubes were heated by direct current; the heating power was from 30 to 300 kW which corresponds to a power of 16 to 160 W/cm at the heating tube. The tubes were smooth and arranged in a smooth square channel at a distance ratio of c/d = 1.283. The Reynolds numbers ranged from 10^4 to $3 \cdot 10^5$. Wall temperatures up to 700°C were measured. The isothermal friction coefficients of the entire bundle, including the channel wall, were determined to be about 7% less than those of the circular tube. Transformed to the conditions applicable to an arrangement with an infinite number of rods, the results were about 3% less than those of the circular tube. The measured Nusselt numbers calculated for an infinite arrangement are also slightly lower than the comparable values of circular tubes. An influence of the temperature factor on the Nusselt number was not observed. (auth)

17666 (KFK-Ext-8/71-3) CRITERIA FOR SELECTION OF THE MEASURING FILTER AND SCANNING FREQUENCY AS WELL AS A METHOD OF CORRECTING OF MEASUREMENT ERRORS APPLIED TO TEMPERATURE MEASUREMENT IN SODIUM. Rittirsch, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Aug 1971. 29p. (In German). Dep. NTIS (U. S. Sales Only).

In experimental investigations with boiling or superheated liquid metals the temperature gradients can reach 2000°C/sec. NiCr-Ni-thermocouples, selected for small dead-time and time constant, are used to measure these fast temperature changes. The temperatures recorded during fast changes of this nature are nevertheless likely to be in error by a considerable amount. The thermal inertia of the thermocouples, a quantity strongly element-dependent, is responsible for this error. The measuring technique must therefore, on the one hand, strive to eliminate a priori, by optimum layout of the analog measuring channels, any additional interference and on the other to correct the measurement errors caused by the thermal inertia of the thermocouples. The interdependence of thermocouple-, filter- cutoff-frequency, filter-type and sampling frequency under the above-mentioned aspects in connection with digital data acquisition was investigated. Results are in the form of graphs and tables, from which it is possible to find the optimum layout for the analog measuring channels. Two methods are described which allow a correction for the measurement error caused by thermal inertia of the thermocouple. The application of these methods is illustrated by a practical example with subsequent comparative evaluation. (auth)

17667 COMBINED FREE AND FORCED LAMINAR CONVECTION IN INCLINED TUBES WITH UNIFORM INTERNAL HEAT GENERATION. Cheng, K. C.; Hong, S. W. (Univ. of Alberta, Edmonton). Nucl. Eng. Des.; 17: No. 3, 345-54(1971).

The effect of uniform internal heat generation on fully developed velocity profiles, temperature profiles, pressure drops and Nusselt numbers is studied for combined free and forced laminar convection with upward flow in inclined tubes subjected to a uniform heating at the tube wall. A numerical solution using a combination of a boundary vorticity method and a line iterative relaxation method is employed. Comparison is made between the numerical analysis and a perturbation analysis available in the literature for a limiting case of horizontal tubes. The perturbation method is known to be valid for rather small values of the parameters representing

heat generation and buoyancy effects. In contrast, the numerical solution is shown to be valid up to reasonably high values of the parameters, where in many cases an asymptotic behavior for flow and heat transfer results already appears. At high Rayleigh numbers the tube inclination angle or body-force orientation effects on flow and heat transfer results are found to be particularly significant for any value of the heat-source parameter. The study is an extension or generalization of earlier work in the literature, dealing with vertical or horizontal tubes. (auth)

17668 EFFECTS OF NONEQUILIBRIUM HEAT, MASS, AND MOMENTUM TRANSFER ON TWO-PHASE SOUND SPEED. Mecredy, R. C.; Hamilton, L. J. (Univ. of Michigan, Ann Arbor). Int. J. Heat Mass Transfer; 15: No. 1, 61-72(Jan 1972).

A model was developed which yielded the speed and attenuation of acoustic waves as a function of frequency in two-phase, one-component media. Nonequilibrium interphase heat, mass, and momentum transfer were included and were found to be important. At low frequencies, the wave speed approached the equilibrium value calculated by $\sqrt{(\partial p/\partial \rho)_s}$. The wave speed in the high frequency limit was characterized by no heat, mass, or momentum transfer between the liquid and vapor phases. The attenuation was large at high frequencies. A comparison of the theory with experiment showed that the leading edges of large amplitude pressure waves travel at the high frequency limit of the sound speed. (auth)

17669 5th AINSE HEAT TRANSFER AND FLUID FLOW CONFERENCE 1971, LUCAS HEIGHTS, AUSTRALIA, AUGUST 23–24, 1971. Abstracts of Papers. Lucas Heights, Australia; Australian Institute of Nuclear Science and Engineering (1971). 50p. (CONF-710832-(Absts.)).

Abstracts of 49 papers dealing with various aspects of heat transfer and fluid flow are presented. Eleven of the papers are directly related to nuclear technology. (Australia)

17670 PRESSURE DROP CORRELATION IN TWO-PHASE FLOW. Lombardi, C.; Pedrocchi, E. (CISE, Milan). Energ. Nucl. (Milan); 19: No. 2, 91-9(Feb 1972).

In the research programs that are being carried out at CISE on two-phase flow, much attention has been devoted to pressure drop problems. A new, recently obtained, general correlation to predict pressure drops in two-phase mixtures is presented, which holds for all the conditions where dispersed or annular dispersed flow is obtained over most of the duct length. An energy balance is referred to for subdividing the overall pressure drop into the usual head, acceleration and friction terms. The friction term has been empirically correlated by properly displaying the effect of various parameters on the basis of ad hoc experiments. No correlated quantities are needed to predict overall pressure drops. The correlation has been thoroughly verified in a number of conditions over a wide range of variables. Finally some questions raised by the correlation are discussed. (auth)

Materials Testing

Refer also to abstracts 17659, 17660, 17885, 17898, 18380, and 18391

17671 (HEDL-TME-71-135) X-RAY REAL-TIME IMAGING FOR NONDESTRUCTIVE TESTING OF FAST FLUX TEST FACILITY FUEL PINS. Jackson, C. N. Jr.; Gray, W. H. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1971. Contract AT(45-1)-2170. 21p. Dep. NTIS.

The need for rapid, thorough and economical inspection of FTR fuel pins has brought about the development of an x-ray imaging system for real-time inspection at Hanford Engineering Development Laboratory (HEDL). The system consists of a shielded facility, an x-ray generating unit and an x-ray sensitive Vidicon camera closed circuit video system. Both dynamic and static inspection of fuel pin internal components can be made. Axial and linear modes of an individual fuel pin motion or synchronized rotation of six fuel pins is possible. Also the pins may be indexed in increments of 30°. Rotation of the fuel pin permits a thorough, 360° observation of individual pellets as well as verification of proper assembly of internal fuel pin components. Chipped corners, undersized pellets or detection of cracks can be readily detected during console-controlled rotation or translation of a fuel pin. Advantages of this system are that it provides the following: a historical record of selected areas; 360° volumetric inspection; 24 × magnification; highly efficient radiographic techniques; and real-time evaluation. A digital display measuring system permits linear measurement of internal parameters such as fuel column length and pellet location. The system employs two new components for imaging of materials, i.e., a beryllium window 260 kV x-ray tube and a lead oxide photo conductive target in the x-ray vidicon tube. The overall efficiency of the x-ray-sensitive vidicon is greatest when an abundance of low x-radiation energy is available. The beryllium window x-ray tube reduces the inherent filtration common to other x-ray tube materials, and thus makes more low-energy radiation available to the vidicon target. The higher kV x-ray tube provides not only more x-rays over the whole spectrum, it specifically supplies a higher maximum energy for greater penetration of the fuel pin material. The inspection unit was designed for complete and economic radiographic examination of the FFTF fuel pin, and as such, will perform materials inspection for integrity and needed dimensional verification. The length of time an operator can perform real-time inspection without exceeding reasonable visual acuity losses has not been established (nor have the throughput rates been adequately evaluated). However, the real-time imaging system provides a more complete inspection as compared to conventional radiography at about a 25% increase in cost during initial operation. It is expected the cost will reduce significantly as the operator becomes more proficient in using the system. (auth)

17672 (SwRI-1228-P-11-17) THIRD MECHANIZED ULTRASONIC INVESTIGATION OF A LAMINAR INDICATION IN THE PLATE OF THE LA CROSSE BOILING WATER REACTOR PRESSURE VESSEL. Topical Report No. 13. (Southwest Research Inst., San Antonio, Tex.). 16 Sep 1971. Contract AT(11-1)-1228. 20p. Dep. NTIS.

Ultrasonic mapping examination of the area containing a laminar indication in the reactor vessel wall near recirculation outlet nozzle no. 1, utilizing the remote scanning device built and designed for this examination is described. (auth)

17673 ESTIMATING THE EFFICIENCY OF A NEUTRON DEFECTOSCOPE IN TESTING LEAD PARTS. Gorbunov, V. I.; Elagin, V. B.; Pekarskii, G. Sh. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 573-5(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 450-2(Apr 1970).

Results of tests conducted to compare the efficiency of neutron defectoscopes with betatron defectoscopes in determining defects in thick metals are presented. It was found that there is a gain in productivity relative to the betatron method for thicknesses of Pb greater than 170 mm. The net cost of testing by means of the neutron defectoscope is lower than that of betatron testing for thicknesses over 120 mm. (J.R.D.)

17674 PROCESS FOR DETECTING AND MEASURING VIBRATIONS USING ULTRASOUND. Marini, Jean; Roule, Maurice (to Commissariat a l'Energie Atomique). French Patent 2,058,542. 3 May 1971. Filed 15 Sep 1969. (In French).

A procedure for detecting and measuring vibrations using ultrasound is described. The acoustic waves emitted by an ultrasonic transducer are reflected by the object being studied and detected when they return to the transducer. The procedure may be used for the systematic control of the vibrations of mechanical parts in the vicinity of a reactor core. (France)

17675 INTENSIFICATION OF PHOTOGRAPHS BY MEANS OF AUTORADIOGRAPHY. Thackray, M.; Roman, D.; Hetherington, E. L. R.; Brian, H. H. (Australian Atomic Energy Commission, Sutherland). Int. J. Appl. Radiat. Isotop.; 23: No. 2, 79-85(Feb 1972).

The intensification of low density photographs by means of autoradiography after rendering the image radioactive was found superior in several respects to common chemical methods of intensification. Reproductions of any desired density can be produced by simply varying the autoradiographic exposure. With underexposed negatives of conventional materials the practical limit of application of the technique is the intensification of photographs which had received about 2% of the optimum exposure. Under some circumstances, this is equivalent to a useful increase in photographic speed which may be of value in such fields as astronomy or the diagnostic use of ionizing radiation. Of many methods investigated for rendering the silver image radioactive, toning with sulphur-35 or exchange with silver-110 m were the most convenient although neutron activation may lend itself to easy automation. (auth)

17676 NONDESTRUCTIVE TESTING OF WELD SEAMS IN PRESSURE VESSELS AND PIPEWORK IN NUCLEAR TECHNOLOGY. Trumpfheller, Rudolf. Schweissen Schneiden; 23: No. 4, 138-40(Apr 1971). (In German).

General safety requirements for welds in steel pressure vessels and pipework for nuclear reactors, and the choice of the relevant nondestructive testing methods, e.g., ultrasonic, radiographic, or magnetic-particle surface-defect techniques, are discussed. The use of the term "complete ultrasonic testing" is defined and reference is made to its significance with regard to the testing of

weld seams in reactor pressure vessels. The need to recognize systematic defects is stressed and extensive testing that is required in the case of the internal clad surfaces of pressure vessels and heat-exchanger tubes is described. Examples of ultrasonic testing-probe arrangements are illustrated and the evaluation of defects is mentioned. (Metals Abstr.)

17677 MEASURING TOOL WEAR: RADIOMETRICALLY. Hill, R. F. (General Motors Corp., Warren, Mich.); Skunda, Michael. Mech. Eng.; 94: No. 2, 22-7(Feb 1972).

A radiometric tool wear method which consists of machining workpieces with a radioactive cutting tool and measuring the amount of material removed from the tool during the cut is described. Before the tool is irradiated, a small fragment is removed from the tool and carefully weighed. This fragment along with the tool is irradiated with neutrons to produce tungsten-187, a radioisotope with a 24-hr half-life. The radioactive fragment is then chemically dissolved, and a known portion of the solution placed in a vial to be used as a counting standard. The irradiated tool is used to machine workpieces, and all chips produced by the cutting operation (along with the tiny bits of tool wear debris) are collected. Tool wear is then determined by comparing the radioactivity of the chip samples to the radioactivity of the counting standard. (T.F.D.)

17678 ESTIMATING THE EFFICIENCY OF THE USE OF A NEUTRON DEFECTOSCOPE IN TESTING LEAD PARTS. Gorbunov, V. I.; Elagin, V. B.; Pekarskii, G. Sh. Zavod. Lab.; 37: No. 4, 450-2(1971). (In Russian).

The general principles underlying the testing of Pb parts by the use of a neutron defectoscope are outlined, with special reference to the question of estimating the productivity and cost of the operation, subject to a pre-specified minimum sensitivity. The efficiency of the neutron defectoscope was compared with that of betatron defectoscopes. An advantage was gained by using the neutron instrument for thicknesses >170 mm. (Metals Abstr.)

Nuclear Explosions

Refer also to abstracts 17719–17722, 17763, 17765, 17768, 18380, and 18381.

17679 (NVO–1163-TM-16(Rev.1)) BASIC ASPECTS OF BPF, PSRV, AND FOURIER AMPLITUDE SPECTRA. Lane, Stephen S. (Environmental Research Corp., Las Vegas, Nev.). Jan 1972. Contract AT(29-2)-1163. 24p. Dep. NTIS.

The Fourier spectrum, the band-pass filter spectrum, and the pseudorelative velocity spectrum are common means of analyzing seismic data. A review of each frequency analysis technique is presented together with its uses, advantages, and disadvantages. For this purpose, the Fourier spectrum is taken to be the basic representation in the frequency domain. A list of references is included as the basis of a broad understanding of the work that has been done in this field. (auth)

Civil Uses

Refer also to abstracts 17334, 17717, and 17718.

17680 (CEA-BIB–152(Add.1)) PEACEFUL USES OF NUCLEAR EXPLOSIONS. GEOLOGY, SEISMOLOGY, BEHAVIOR OF THE GROUND AND ROCKS. Berton, Micheline (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Aug 1971. 203p. (In French and English). INIS.

This bibliography consists of 643 references. The documents are classified into two chapters: seismology and geology, the study of the ground and of rock fractures after nuclear explosions or exposure to very high pressures or temperatures. Several indexes are to be found: subjects, reports, review articles, congresses, theses. (INIS)

17681 (PNE-R–55) PROJECT RULISON: SUMMARY OF RESULTS AND ANALYSES. Reynolds, Miles Jr. (Austral Oil Co., Inc., Houston, Tex.). [1971]. 21p. Dep. NTIS.

Project Rulison was designed to determine the feasibility of using underground nuclear explosions for stimulating natural gas production from the Mesaverde formation in the Rulison Field, Colorado. The explosive was detonated on Sept. 10, 1969. Testing of the well was begun in Oct. 1970 and concluded in April 1971. Test results are reported for flow tests, gas analyses, production of water and CO_2, and well performance. The results indicate that the technical objectives were successfully achieved. The results of this project will be used to make an economic evaluation of using nuclear technology for developing gas-bearing formations. (L.C.L.)

Protective Structures and Equipment

Refer also to abstract 18412.

17682 (CNEA–301) HOT CELL FOR MANIPULATION OF SEALED SOURCES. Papadopulos, Celso C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1971. 14p. (In Spanish). Dep. NTIS (U. S. Sales Only).

The general concept, design details, and construction features of a hot cell are described. (tr-auth)

17683 SCATTERING OF X RADIATION ON BUILDING MATERIALS AND THE RADIATION BURDEN OF THE PHYSICIAN IN X-RAY ROOMS. Goettel, K.; Kraft, A. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Munich). Fortschr. Geb. Roentgenstr. Nuklearmed.; 115: No. 4, 522-7(Oct 1971). (In German).

Radiographic examination during which doctors and their assistants have to remain in the x-ray room result in radiation exposure of these persons. Screens and protective clothing cannot totally prevent this. The main sources of the radiation is that transmitted through the patient and scattered from walls, ceiling, and floor. Early investigations regarding the scattering properties of building and protective material have indicated particularly low backscatter for enameled iron. Further tests of different types of enamel have shown that cement covered with white enameled iron sheets reduced scatter to 15% of the original value. Measurements in x-ray rooms with screening apparatus have shown that covering a six square meter cement wall with enameled iron sheets will reduce the radiation dose to the radiologist by 30 to 70%, depending on the position of the radiographic apparatus. It has further been shown that bringing the apparatus closer to the wall does not result in increased radiation doses, at least until the distance becomes very small. Enameled iron is produced as a material for covering walls in the shape of normal sheets. (auth)

17684 AUTOMATIC FIRE EXTINGUISHING (3 Nov 1971) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE–2166).

3 drawings.

A modular fire extinguishing system provides reliable fire protection in glove boxes and shielded cells. The system is flexible and uses commercially available components. This system is not suitable for extinguishing metal fires. Electric-switch operated valves are used for manual or automatic operation. A rate-anticipating thermal detector is placed near the top center of the box or cell. The extinguishing agent, 5% volume Halon 1301 (bromotrifluoro methane), reacts chemically with the intermediate products involved in the propagation of flame. The reaction is fast and starts before the effective concentration is obtained. The increase in the volume during discharge and evaporation of the small amount of Halon 1301 does not upset the control of the atmospheric pressures in boxes or cells. (For details see TID-4100, Suppl 68) (see also NSA 25: 48876) (F.S.)

17685 EXHALATION DEVICE FOR BREATHING MASK. Ulmann, Paul (to Commissariat a l'Energie Atomique). British Patent 1,258,597. 30 Dec 1971. Priority date 11 Jul 1968. France.

An exhalation device for a breathing mask is described. The exhaled air in this system is discharged through an outlet valve as soon as the pressure within the mask exceeds the pressure of the surrounding atmosphere by a predetermined difference. In one modification known as the isolating mask, the facepiece is supplied with a breathing mixture at a pressure which is distinctly higher than that of the surrounding atmosphere to prevent the penetration of toxic gases or dust particles from the atmosphere through the facepiece at any locations in which leak-tightness is faulty. In another modification, known as the filtering mask, the facepiece is supplied from the surrounding atmosphere through a filter cartridge and an inlet valve which opens under the action of the partial vacuum which is developed within the mask as a result of inhalation by the wearer. (J.R.D.)

Safety Engineering

Refer also to abstracts 18418, 18420, and 18425.

17686 (CLOR–84/D) METHODS OF $^{131}I_2$ AND $CH_3{}^{131}I$ VAPORS GENERATION FOR STUDIES AND CONTROL OF RADIO-

ACTIVE AIR CONTAMINATION. Krzesniak, Jerzy (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1971. 53p. (In Polish). Dep. NTIS (U. S. Sales Only).

Some of the problems of air contamination by ^{131}I inside nuclear facilities and in their environment during normal operations and in case of nuclear accident are briefly reviewed. Trapping of ^{131}I and $CH_3{}^{131}I$ in the form of aerosols and vapors by filters is discussed. The detailed discussion of preparation of iodine and methyl iodide sources labeled with radioiodine, as well as the development of experimental equipment for determination of charcoal filters efficiency, under various operational conditions has been given. The principal variables applied in the measurements were temperature, relative humidity, concentration of iodine and methyl iodide, as well as the surface velocity of the sweeping air. (auth)

17687 (IAEA/NPR-12) MEETING OF SPECIALISTS ON OPERATIONAL SAFETY OF SODIUM CIRCUITS, RISLEY, UK, 17–19 MARCH 1971. Summary Report. (International Atomic Energy Agency, Vienna (Austria)). 170p. (CONF-710335). Dep. NTIS (U. S. Sales Only).

Significant differences between practices appropriate to experimental sodium rigs and those appropriate to the sodium circuits of reactors were discussed. Experimental rigs are frequently highly instrumented and operated for relatively short periods under the close attention of professional staff; reactor circuits must operate reliably for long periods (~30 years) with much less professional attention. The emphasis of the discussions was on the design, construction, and operation of experimental sodium rigs, although attention was paid to particular aspects of reactor circuits. (auth)

Vacuum Engineering

Refer also to abstract 17904.

17688 DEVICE FOR CONTROLLING THE PRESSURE IN A MOLECULAR VACUUM OR ULTRAHIGH VACUUM. Aubry, Bernard; Bernardet, Henri; Choumoff, Serge; Mativet, Jean; Sauneuf, Richard (to Commissariat a l'Energie Atomique). French Patent 2,064,631. 28 Jun 1971. Filed 6 Oct 1969. (In French).

A device is described for accurately controlling the pressure in a molecular or ultrahigh vacuum. It consists of a spherical enclosure connected to a pumping unit by the orifice of a diaphragm, and a cone, controlling the conductance of this orifice. This cone is rigidly connected to a mobile axis controlled from outside the sphere. Gas is fed into the sphere by a tube having many holes. The pressure within the sphere depends upon the conductance of the orifice which is controlled by the cone and the rate at which the gas arrives. The tube is perpendicular to the axis of the cone. (France)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstract 18490.

17689 (ORNL-TM-3563) AVAILABILITY OF NATURAL RESOURCES FOR MOLTEN-SALT BREEDER REACTORS. Bell, M. J. (Oak Ridge National Lab., Tenn.). 11 Nov 1971. 26p. Dep. NTIS.

An investigation has been made of the availability of, and the anticipated demand for, materials of importance to the MSBR program. Materials considered included the constituents of Hastelloy-N, coolant salt, fuel salt, and materials required for construction and operation of the processing plant. It was found that the world reserves of beryllium, fluorine, and bismuth are being rapidly depleted by non-MSBR uses, and that these reserves can be expected to be exhausted by the turn of the century. Ample resources of beryllium and fluorine are available to sustain a large MSBR industry, but development of an improved mining technology will be required to make their recovery economical. Ore from which thoria is recoverable for $10/lb will be available into the middle of the twenty-first century. MSBR demands for all materials, with the possible exception of hafnium used in modified Hastelloy-N, comprise only a small fraction of the predicted world primary demand for these minerals. The fuel cycle cost was found to be relatively insensitive to the price of raw materials; an increase in the cost of carrier salt to ten times its present level, or an increase in the price of thoria or Hastelloy-N to three times their present levels, would increase the fuel cycle cost by 0.1 mill/kWh. (auth)

17690 URANIUM IN AUSTRALIA'S NORTHERN TERRITORY. Com. Naz. Energ. Nucl., Notiz.; 17: No. 10, 64-6(Oct 1971). (In Italian).

A review of the latest uranium deposits discovered in Australia's important uranium province of the Northern Territory is presented. (auth)

17691 URANIUM CONTENT OF THE OCEANIC UPPER MANTLE. Aumento, F.; Hyndman, R. D. (Dalhousie Univ., Halifax, Nova Scotia). Earth Planet. Sci. Lett.; 12: No. 4, 373-84(Dec 1971).

Fission track determinations of both the whole rock contents and the distribution of uranium in individual phases were made on twenty serpentinized ultramafic rocks from the Mid-Atlantic Ridge at 45°N (Hudson Geotraverse) and 52°N (Gibbs Fracture Zone). The rocks are thought to represent uppermost oceanic upper mantle material. Whole rock uranium concentrations, varying from 0.19 to 0.70 ppM, reflect more the subsequent histories of metasomatism (serpentinization, amphibolization and rodingitization) than concentrations of the original fresh rocks. Relic minerals reveal that, unlike continental mantle equivalents, most of the uranium is homogeneously distributed in primary orthopyroxenes (1 ppM), and to a lesser extent (0.2 ppM) in primary clinopyroxenes. Primary olivine is relatively depleted in uranium (0.03 ppM), as is primary chrome spinel (0.09 ppM). Extrapolation to pre-metasomatic conditions suggests that at the time of crystallization these ultramafic rocks had concentrations of at least 0.1 to 0.5 ppM uranium, up to an order of magnitude greater than expected. These concentrations suggest that the ultramafic rocks are unlikely to be directly genetically related to the overlying basalts and gabbros containing 0.25 ppM uranium, but are probably primary ultramafic material from which there has been no previous episode of basalt extraction. These uranium concentrations suggest that the oceanic upper mantle (plate) has quite high radioactive heat production in contrast to low heat production in the continental upper mantle. The equality of oceanic and continental heat flows is explained by the data, since the total heat produced in an oceanic plate is estimated to be about equal to that of the continental crust. One can construct a model that has an isothermal, low velocity (partial melt) layer at a shallower depth under the oceans than under the continents and that has the same heat flux from below the oceanic and shield plates. Lateral convective heat transfer in the low velocity layer is not required. High radioactive heat production of the oceanic plate can explain the high heat flows measured behind trenches with downgoing slabs. (auth)

Radioactive Effluents

Refer also to abstracts 17697, 17714, 18407, 19806, and 19811.

17692 (DOCKET-50201-107) WEST VALLEY REPROCESSING PLANT. Quarterly Report, October 1-December 31, 1971. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 31 Jan 1972. 9p. Dep. NTIS.

Information is presented on analysis of milk from the NFS farm, the radioactivity discharged from the plant lagoons, the particulate radioactivity discharged via the plant stack and surveillance tests. (M.C.G.)

17693 (WASH-1512(Dr.)) ROVER FUELS PROCESSING FACILITY. National Reactor Testing Station, Idaho. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 146p. Dep. NTIS.

The project proposed would consist of modifying a small portion of the existing Idaho Chemical Processing Plant (ICPP) to store and subsequently reclaim useable uranium from the Rover fuels. It would be located at the National Reactor Testing Station (NRTS), which is situated on a plain in Southeastern Idaho and consists of a flat area covered primarily with sagebrush and grass. The principal wildlife residing in this area consists of antelope, coyotes, rabbits, and small rodents. Rover fuel is stored at the Nuclear Rocket Development Station (NRDS) in Nevada and contains about 2600 kg of highly enriched uranium (93% ^{235}U) that is not being utilized in its present form. The proposed operation would recover uranium worth $26 million for reuse at an estimated cost of $4.5 million. Upgrading of the containment of the radionuclides in the fuel by storage at a single facility designed specifically to handle radioactive material is considered. Environmental costs associated with this project will be the temporary use of less than one acre of restricted land within the boundaries of NRTS for an indefinite period of time and the release of small quantities of radioactive fission products in concentrations several orders of magnitude below current discharge guidelines. Nonradioactive chemicals will be released to the environment in concentrations less than 0.1% of federal and state regulations. The facility will be designed to minimize the quantities of radioactive and nonradioactive discharges released. The anticipated benefits were assessed and balanced against the environmental and economic costs, and available alternatives considered. (M.C.G.)

Radioactivity Transport and Monitoring

Refer also to abstracts 17340, 17356, 17757, 17836, and 18407.

17694 (COO-3462-4) URANIUM GEOCHEMISTRY IN CARBONATES USING THE FISSION TRACK METHOD. Technical Progress Report. Miller, Donald S.; Friedman, Gerald M. [Rensselaer Polytechnic Inst., Troy, N. Y.]. Jan 1972. Contract AT(11-1)-3462. 12p. Dep. NTIS.

17695 RESULTS OF A FOLLOWUP RADIATION SURVEY ON COLOR TELEVISION SETS, SUFFOLK COUNTY, NEW YORK. Becker, Seymour (Suffolk County Dept. of Health, Smithtown, N. Y.). Radiol. Health Data Rep.; 12: No. 9, 457-8(Sep 1971).

The U. S. Public Health Service's regulatory standard required that television receivers manufactured after January 15, 1970, produce no radiation exceeding an exposure rate of 0.5 mR/h at 5 cm from any point on the external surface of the receiver. Results of a survey of color television sets manufactured after the effective date of the Public Health Service standard show improvement in the reduction of radiation emission. Those color television sets manufactured before the effective date of the standard that are being serviced by the factory-trained television servicemen reveal no levels of x-radiation emissions above natural background emissions. With the cooperation of the independent television serviceman and the individual color television set owner, it appears that the x-radiation problem in color television receivers will be eliminated. (auth)

17696 NUCLEAR METHODS IN METEOROLOGY AND HYDROLOGY. Kruger, Paul (Stanford Univ., Calif.). pp 118-26 of Nuclear Methods in Environmental Research. /Vogt, James R. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

The spectrum of nuclear techniques has been employed in essentially the entire spectrum of geofluid circulations on earth.

For field applications, nuclear methods can be grouped as radiation measurement of material properties or as tracer measurement of processes, motion, location, or time. Several types of isotopic tracers are useful in meteorology and hydrology, each offering capability for specific types of investigation. These are environmental isotopes, which can be stable, activable, or radioactive, or added tracers, which can be activable or radioactive. Geofluid studies can involve such phenomena as isotopic fractionation, environmental production history, equilibria and perturbations in geofluid cycles, and various scales of motion, circulation, transport, and dispersion processes. Applications in meteorology include such studies as global and synoptic scale circulation patterns, world-wide and local deposition phenomena, examination of large and small scale storms, and aerosol dispersion kinetics. Applications in surface water hydrology include such studies as snow and sediment gaging, evaluation of the precipitation-runoff cycle, and measurement of streamflow, storage, evapotranspiration, and dispersion. Applications in ground water hydrology include such studies as soil moisture and well logging, infiltration and percolation processes, evaluation of ground water movement, aquifer properties, borehole effects, and transport and dispersion processes in porous media. (auth)

17697 RADIONUCLIDES IN THE ENVIRONMENT. 155th Meeting of the American Chemical Society, San Francisco, Calif., April 1–3, 1968. Advances in Chemistry Series No. 93. Washington, D. C.; American Chemical Society (1970). 538p. $15.00. (CONF-680476).

Twenty eight papers presented at the conference are included. A separate abstract was prepared for each of 22 pages. The remaining 6 papers were previously abstracted for NSA (see CONF-680476 in the Report Number Index). (M.C.G.)

For abstracts of individual papers see: 17431, 17698, 17699, 17713–17724, 17730, 17735, 17736, 17748, 17802, 17803, and 17856.

17698 TRANSPORT OF FISSION-PRODUCT CESIUM FROM SODIUM. Tang, I. N.; Castleman, A. W. Jr.; Munkelwitz, H. R. (Brookhaven National Lab., Upton, N. Y.). Advan. Chem. Ser.; No. 93, 71-82(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

The vaporization of fission-product cesium from liquid sodium into flowing inert gases was investigated at 730°K. The cesium release rate was found to depend on both the liquid depth of sodium and the molecular weight of the inert carrier gases. A general release equation is developed by considering diffusion in both the liquid and gas phases. This equation is shown to represent the experimental results very well. The limiting case of maximum extent of release, expressed in terms of fractional fission-product vaporization as a function of the fraction of sodium vaporized, can often be calculated from thermodynamic considerations. (auth)

17699 CORRELATION OF RADIONUCLIDE FRACTIONATION IN DEBRIS FROM A TRANSIENT NUCLEAR TEST. Lal, J. R.; Freiling, E. C. (Naval Radiological Defense Lab., San Francisco). Advan. Chem. Ser.; No. 93, 337-51(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Fractionation correlation techniques have been applied to cloud, fallout, and ground-filter samples from the Transient Nuclear Test of January 1965. Although safety analysts do not consider fractionation effects to be of operational importance for this type of event, analysis of such data provides insight into the mechanisms of debris formation. The results show many similarities to the correlations observed for fallout. Those dissimilarities found indicate the importance of escape processes to the formation mechanisms for this type of debris. (auth)

17700 STUDY OF THE DISTRIBUTION OF RADIOACTIVITY IN MINERALS OF PENINSULAR INDIA. Sastri, C. S.; Sivaramakrishnan, V. (Indian Inst. of Tech., Madras). J. Geol. Soc. India; 12: No. 2, 180-3(Jun 1971).

The distribution of radioactivity in some of the rock formations of Peninsular India is reported. The alpha activity and equivalent uranium of various minerals have been determined using RCA 6199 photomultiplier coated with silver activated zinc sulfide as the phosphor. The observed values for the radioactive content of phosphatic nodules were in the range of 30 to 60 ppM and those of vermiculite and cordierite in the range of 10 to 20 ppM. The results of the acid leaching study of zircons, garnet, and ilmenite are discussed. (INIS)

Atmosphere

Refer also to abstracts 17341, 17363, 17430, 17762, and 17826.

17701 (HASL-246) FALLOUT PROGRAM. Quarterly Summary Report, September 1–December 1971. Hardy, Edward P. Jr. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Jan 1972. 167p. Dep. NTIS.

Data and information on fallout and radioisotope distribution throughout the world are presented in 8 sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 17702–17706 and 17739–17741.

17702 (HASL-246, I,2-17) PLUTONIUM IN THE NEIGHBORHOOD OF ROCKY FLATS, COLORADO: AIRBORNE RESPIRABLE PARTICLES. Volchok, H. L.; Knuth, R.; Kleinman, M. T. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Several experiments were carried out, off-site, but close to the Rocky Flats plutonium plant, to determine the respirable fraction of the resuspended ^{239}Pu. The results indicate that in this area, with concentrations in excess of 1 fCi/m^3, the respirable fraction is about 0.2 to 0.4. These experiments also provide evidence that the main source of the resuspended ^{239}Pu is probably located somewhat east of the plant site, and that very steep vertical gradients of Pu concentrations may be present in the air in this vicinity. (auth)

17703 (HASL-246, I,53-68) COMPARISON OF THE ORIGINAL AND MODIFIED HIGH-VOLUME-3000 AIR EJECTOR SAMPLERS. Ashenfelter, T. E.; Telegadas, K. (National Oceanic and Atmospheric Administration, Silver Spring, Md. Air Resources Labs.).

A modification of the High-Volume-3000 air ejector sampler (HV3K) has been developed and flight tested against an original HV3K sampler. Results indicate the original sampler became contaminated with radioactive debris during its ascent to sampling altitude. This confirmed the earlier results reported by Ashenfelter and Telegadas (1970). The modified HV3K sampler is considered to be contamination-free during its ascent to sampling altitude. (auth)

17704 (HASL-246, I,69-106) ^{14}C MEASUREMENTS IN THE STRATOSPHERE FROM A BALLOON-BORNE MOLECULAR SIEVE SAMPLER. Telegadas, K. (National Oceanic and Atmospheric Administration, Silver Spring, Md. Air Resources Labs.); Gray, J. Jr.; Sowl, R. E. (Argonne National Lab., Ill.); Ashenfelter, T. E. (National Oceanic and Atmospheric Administration, Silver Spring, Md. Air Resources Labs.).

A new sampler for collection of atmospheric CO_2 utilizing molecular sieve adsorption has been flown on operational USAEC balloon flights beginning in mid-1970 at four locations in the northern and two locations in the southern hemisphere at altitudes ranging from 21 to 37 km. The CO_2 collections were analyzed radiometrically for excess carbon-14 (^{14}C due to nuclear weapons testing) and by mass spectrometric analysis for $\delta^{13}C$ and $\delta^{18}O$. Only the excess ^{14}C and $\delta^{13}C$ data are given. Although the $\delta^{18}O$ data are not presented, a discussion of the results is given. The $\delta^{13}C$ values decrease with altitude from 21 to 37 km. This decrease is attributed to fractionation in the molecular sieve beds during the collection of CO_2 rather than in nature or in the laboratory. The excess ^{14}C data are presented in two latitudinal cross-sections from which the stratospheric excess ^{14}C burden was determined. (auth)

17705 (HASL-246, II,1-6) HASL FALLOUT PROGRAM DATA. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Surveillance activities are summarized and referenced. Those included are on fallout deposition, surface air sampling, radiostrontium in water and milk, and ^{90}Sr in diets. (J.R.D.)

17706 (HASL-246, III,1-20) DATA FROM SOURCES OTHER THAN HASL. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Data on worldwide fallout are presented. These data were collected by EURATOM, Argonne National Laboratory, and by global deployment of USAF aircraft. (J.R.D.)

17707 (HASL-246(App.)) FALLOUT PROGRAM. Quarterly Summary Report, September 1–December 1971. [Hardy, Edward P. Jr.] (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Jan 1972. 431p. Dep. NTIS.

Data and information are presented on ^{89}Sr and ^{90}Sr monthly deposition at world land sites, radiostrontium deposition at

Atlantic Ocean weather stations, radionuclides in surface air, and radiostrontium in milk and tap water. (J.R.D.)

17708 (INIS-mf-142) BIBLIOGRAPHY ON RADIOACTIVE FALLOUT (1965–70). Nagarathna, R. A. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). Apr 1971. 233p. INIS.

The bibliography contains approximately 600 references to literature published during 1965 to 1970. The references are divided into 16 categories viz., Bibliographies, General, Analysis, Animals, Atmosphere, Contamination and Decontamination, Control and Monitoring, Dose Estimation, Environment, Food and food chains, Human beings, Instrumentation, Plants, Radiation protection, Soil, and Water. Under each heading, the material is listed alphabetically by authors. Author, report number, and keyword indexes are also given. (INIS)

17709 (NIRS-RSD-32) RADIOACTIVITY SURVEY DATA IN JAPAN. (National Inst. of Radiological Sciences, Chiba (Japan)). Aug 1971. 21p. Dep. NTIS (U. S. Sales Only).

Results are reported from fallout monitoring studies in Japan. Data are presented on the content of ^{137}Cs and ^{90}Sr in samples of air-borne dusts, soil, surface waters, drinking water, and the total diet collected at various locations throughout Japan during the first half of 1971. (C.H.)

17710 (NRL-F-44) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND. Quarterly Report, January–March 1971. (National Radiation Lab., Christchurch (New Zealand)). 11p. Dep. NTIS (U. S. Sales Only).

The results of routine monitoring of fallout during the first quarter 1971 are presented. The levels measured were compared with those of the preceding quarters in 1970. In general, the total beta activity in air remained about the same as in the previous quarter. However, the levels in rain were lower at most stations. The deposition of ^{90}Sr in rain and the levels of ^{90}Sr and ^{137}Cs in milk increased very slightly during the quarter. The deposition of ^{89}Sr from the 1970 French tests showed the expected decrease due to radioactive decay and by March 1971 the average ratio of ^{89}Sr to ^{90}Sr had fallen to 4. The New Zealand country-wide average level of ^{90}Sr in milk for the twelve months ending March 1971 was 2.3% of the reference level. The average level for ^{137}Cs in milk for the same period was less than 0.4% of the reference level. (auth)

17711 (STI/DOC-10/129) ENVIRONMENTAL ISOTOPE DATA NO. 3: WORLD SURVEY OF ISOTOPE CONCENTRATION IN PRECIPITATION (1966–1967). (International Atomic Energy Agency, Vienna (Austria)). Sep 1971. 402p. IAEA $8.00.

Tabulated monthly data for 1966 are presented on the amount of atmospheric precipitation and the content of environmental isotopes, deuterium, tritium, and ^{18}O, in that precipitation at sampling stations in 65 worldwide countries and territories. A brief introduction described the data collection network, the units of measurement used, sampling and analysis information, and calculation procedures. (L.C.L.)

17712 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 12: No. 9, 478–82 (Sep 1971).

Data and information are presented on gross beta radioactivity in surface air and precipitation in U. S. during May 1971, Canadian air and precipitation monitoring during May 1971, and Pan American air sampling program in May 1971. (J.R.D.)

17713 MASS-TRANSFER MECHANISMS IN SOURCE-TERM DEFINITION. Freiling, E. C. (Naval Radiological Defense Lab., San Francisco). Advan. Chem. Ser.; No. 93, 1–12 (1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

The condensation of trace concentrations of radioactive vapor onto spherical particles of a substrate is discussed. For this situation the relation between the engineering approach, the molecular approach, and the fluid-dynamic approach are illustrated for several different cases of rate limitation. From these considerations criteria are derived for the use of basic physical and chemical parameters to predict the rate-controlling step or steps. Finally, the effect of changing temperature is considered and the groundwork is thereby laid for a kinetic approach to predicting fallout formation. The relation of these approaches to the escape of fission products from reactor fuel and to the deposition of radon and thoron daughters on dust particles in a uranium mine is indicated. (auth)

17714 SPHERES: DIFFUSION-CONTROLLED FISSION PRODUCT RELEASE AND ABSORPTION. Norman, J. H.; Winchell, P.; Dixon, J. M.; Roos, B. W.; Korts, R. F. (Gulf General Atomic Inc., San Diego, Calif.). Advan. Chem. Ser.; No. 93, 13–34(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Concern about fission-product release from coated reactor fuel particles and fission-product sorption by fallout particles has provided stimulus to understand diffusion. In a fallout program mathematics of diffusion with simple boundary conditions have been used as a basis for an experimental method of determining diffusion coefficients of volatile solutes and a calculational method for estimating diffusion profiles with time-dependent sources and time-dependent diffusion coefficients. The latter method has been used to estimate the distribution of fission products in fallout. In a fission-product release program, a numerical model which calculates diffusion profiles in multicoated spherical particles has been programmed, and a parametric study based on coating and kernel properties has provided an understanding of fission product release. (auth)

17715 TRANSPORT PATTERNS AND RESIDENCE TIMES FOR ATMOSPHERIC TRACE CONSTITUENTS VS. ALTITUDE. Martell, E. A. (National Center for Atmospheric Research, Boulder, Colo.). Advan. Chem. Ser.; No. 93, 138–57(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Mechanisms and rates of transport of nuclear test debris in the upper and lower atmosphere are considered. For the lower thermosphere vertical eddy diffusion coefficients of from 3 to 6×10^6 cm^2 sec^{-1} are estimated from twilight lithium enhancement observations. Radiochemical evidence for samples from 23 to 37 km altitude at 31°N indicates poleward mean motion in this layer. Large increases in stratospheric debris in the southern hemisphere in 1963 and 1964 are attributed to debris from Soviet tests, transported via the mesosphere and the Antarctic stratosphere. Most of the carbon-14 remains behind in the Arctic stratosphere. $^{210}Bi/^{210}Pb$ ratios indicate aerosol residence times of only a few days at tropospheric levels and only several weeks in the lower stratosphere. Implications for the inventory and distribution of radioactive fallout are discussed. (auth)

17716 CHARACTERIZATION OF RADIOACTIVE PARTICLES FROM NUCLEAR WEAPONS TESTS. Heft, Robert E. (Univ. of California, Livermore). Advan. Chem. Ser.; No. 93, 254–81 (1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Early time aerial filter samples of the stabilized clouds produced by past nuclear weapons tests have been reexamined to determine mass and radioisotopic distribution as a function of particle size. The particles, after removal from the cellulose fiber filter by ashing, were separated into size groups by sedimentation in stabilized fluid columns. The mass and radioisotopic composition of the particle groups were determined and used to generate distribution functions. For airburst detonations the distribution data can be fitted by a single normal distribution function; for Coral Island surface bursts a linear combination of two lognormal functions is needed; for cratering detonations, a linear combination of three lognormal distribution functions is required. The number of functions required is related to the number of discrete particle classes generated by the detonation. (auth)

17717 OBSERVED FRACTIONATION IN GROUND LEVEL FALLOUT FROM THREE NUCLEAR CRATERING DETONATIONS. Gibson, Thomas A. Jr. (Univ. of California, Livermore). Advan. Chem. Ser.; No. 93, 296–300(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Data relating to radionuclide deposition (fallout) within a few miles of the Danny Boy, Sedan, and Palanquin nuclear cratering shots are examined for evidence of fractionation. The fractionation index is computed for several fission-product mass chains produced in each event. For the three events studied only Danny Boy showed unambiguous evidence of fractionation in the early fallout, and the degree of fractionation was small. In Danny Boy there was only a factor of four difference between most enriched and most depleted species, compared with the factors of several hundred that have been observed in many late time samples of airborne debris. If this small amount of fractionation proves to be true in general for cratering shots, predictions of early-fallout gamma-radiation patterns will be simplified. (auth)

17718 SMALL BOY REVISITED: AN EXERCISE IN THE RECOVERY OF QUESTIONABLE DATA FROM A FIELD OPERATION. Crocker, G. R.; Freiling, E. C. (Naval Radiological

Defense Lab., San Francisco). Advan. Chem. Ser.; No. 93, 301-36(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

The large body of radiochemical data available from the low yield land-surface event Small Boy has been re-examined for internal consistency by a variety of methods. It was possible to show that certain portions of the data are not sufficiently reliable to be useful for establishing the fractionation behavior of fission-product radionuclides in the nuclear debris. Certain other parts of the data are shown to need adjustment for calibration differences which existed between the four laboratories which performed the analyses. Despite the shortcomings of the data, it was possible to establish that the relationships which existed among the fractionating radionuclides were qualitatively similar to those previously observed for other events. Other features of the data appear to be unique to Small Boy. (auth)

17719 SPECIFIC ACTIVITY OF NUCLEAR DEBRIS FROM GROUND SURFACE BURSTS AS A FUNCTION OF PARTICLE SIZE. Nathans, M. W. LFE Corp. Richmond, Calif.). Advan. Chem. Ser.; No. 93, 352-9(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Cloud samples from five coral surface bursts and one silicate surface burst were subjected to a size separation by means of a density gradient column. The fractions were analyzed for ^{90}Sr, ^{147}Pm, and uranium. One sample was also analyzed for ^{137}Cs and ^{144}Ce. Fraction weights were obtained by direct weighing or by matrix element analysis. Mean diameters of the particles in the size fractions were determined from size distribution measurements by optical and electron microscopy. The specific activities are varying functions of the radioactive species. No systematic differences between the behavior of ^{147}Pm and ^{90}Sr are apparent as a function of yield. Uranium behaves almost identically to ^{90}Sr. There is evidence of a strong decrease in the specific activity at particle sizes above 60 μ. (auth)

17720 PARTICLE SIZE DISTRIBUTION OF NUCLEAR CLOUD SAMPLES. Nathans, M. W. (LFE Corp., Richmond, Calif.); Thews, R.; Russell, I. J. Advan. Chem. Ser.; No. 93, 360-80(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

The size distributions of the particles in cloud samples from three coral surface bursts and one silicate surface burst were determined by optical and electron microscopy. These distributions were approximately lognormal below about 3 μ, but followed an inverse power law between 3 and ca. 60 or 70 μ. The exponent was not determined unequivocally, but it has a value between 3 and 4.5. Above 70 μ the size frequency curve drops off rather sharply as a result of particles having been lost from the cloud by sedimentation. The effect of sedimentation was investigated theoretically. Correction factors to the size distribution were calculated as a function of particle size, and theoretical cutoff sizes were determined. The correction to the size frequency curve is less than 5% below about 70 μ, but it rises rather rapidly above this size. The corrections allow the correlation of the experimentally determined size distributions of the samples with those of the clouds, assuming cloud homogeneity. (auth)

17721 COMPARISON BETWEEN CLOUD SAMPLES AND CLOSE-IN GROUND FALLOUT SAMPLES FROM NUCLEAR GROUND BURSTS. Tompkins, R. C. (Army Ballistic Research Labs., Aberdeen Proving Ground, Md.); Russell, I. J.; Nathans, M. W. Advan. Chem. Ser.; No. 93, 381-400(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

In several instances the radiochemical composition of fallout samples could not be derived by extrapolating the specific activity-particle size curves obtained from cloud samples. This may be explained by assuming that the close-in fallout originates primarily from soil horizons close to the exploding device which are ejected from the device environs without spending an appreciable amount of time in the cloud. Related observations show that the specific activities of individual particles of comparable size in cloud samples may vary considerably, apparently as a function of the degree of alteration resulting from the thermal history of the particles. Thus, the activities of samples may vary according to the relative amounts of altered and unaltered material present in the samples. (auth)

17722 RADIOCARBON IN THE ENVIRONMENT. Fairhall, A. W.; Young, J. A. (Univ. of Washington, Seattle). Advan. Chem. Ser.; No. 93, 401-18(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Prior to 1950 the worldwide inventory of ^{14}C was 2.2×10^{30} atoms. Nuclear tests added an additional 6×10^{28} ^{14}C atoms to the atmosphere. This had a dramatic effect: for a time the ^{14}C concentrations of the troposphere at midlatitudes of the northern hemisphere were double their pre-1950 levels. The decline of the ^{14}C levels of the atmosphere, owing to atmospheric mixing and exchange of CO_2 with the sea, has given valuable insight into both of these processes. The ^{14}C levels in the oceans are increasing as a result of this exchange. This increase should prove valuable as a tracer in oceanography. Other potential applications of the increase of ^{14}C in the atmosphere and the sea are discussed. (auth)

17723 RELATION OF RADON CONCENTRATION IN THE ATMOSPHERE TO TOTAL MOISTURE DETENTION IN SOIL AND ATMOSPHERIC THERMAL STABILITY. Cox, William M.; Blanchard, Richard L.; Kahn, Bernd (Dept. of Health, Education, and Welfare, Cincinnati). Advan. Chem. Ser.; No. 93, 436-46 (1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Average monthly morning radon concentrations in ground-level air at Cincinnati, Ohio, based on daily measurements of radon-daughter concentrations, are reported for the period from 1959 to 1967. Monthly averages ranged from 120 to 1520 pCi/cu. meters; maxima occurred from August to October and minima from February to April. Two alternative linear equations for predicting average monthly radon concentrations from atmospheric stability and total moisture detention in soil were derived. Radon concentrations varied directly with atmospheric stability and inversely with total moisture detention. Both correlation coefficients were 0.94, and 50 mean monthly values were predicted within 20% on the average. (auth)

17724 RADIOCHEMICAL DATING OF NUCLEAR WEAPON DEBRIS PRECIPITATED FROM CYCLONIC STORMS OVER THE CALIFORNIA COAST. Kruger, Paul (Stanford Univ., Calif.). Advan. Chem. Ser.; No. 93, 447-86(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Radiochemical analyses of the fission products ^{140}Ba, ^{89}Sr, and ^{90}Sr in precipitation from three Pacific cyclones were examined as functions of time and latitude along the California coast to estimate the fractional contribution of nuclear debris from recent nuclear weapons tests. The estimates are based upon the assumptions that the observed fission products originated solely from announced tests in the atmosphere and were produced with the same relative yields as those reported for U. S. nuclear weapons. The analyses show evidences of fractionation of these fission products in the precipitation along the coast in each of the three cyclone storms studied. In accordance with the given assumptions, the fractionation seems to be associated with the precipitation patterns resulting from the meteorological features of the storms. (auth)

17725 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 12: No. 10, 529-38(Oct 1971).

A summary of data on environmental radioactivity at the Lawrence Radiation Laboratory from July through December 1970 is presented. (J.R.D.)

17726 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 12: No. 10, 521-8(Oct 1971).

Data and information are presented on gross beta radioactivity in surface air and precipitation in US in June 1971, results of Canadian air and precipitation monitoring in June 1971, Pan American air sampling program in June 1971, and Mexican air monitoring during August 1970 through January 1971. (J.R.D.)

17727 NATURAL RADIOCARBON IN BEPPU HOT SPRING WATERS. Oda, Toshiyuki (Kyushu Univ., Beppu, Japan). Nippon Kagaku Zasshi; 92: No. 11, 1025-6(Nov 1971). (In Japanese).

The natural radiocarbon content in water (six samples) and in the atmosphere of Beppu Hot Spring was measured by methane counting. Deviation from the standard NBS sample was expressed as plus or minus $\delta^{14}C\%$. The values for the 6 hot spring waters were between −28.2% and 100%, and that in the atmosphere was +37.5%. (auth)

Soil

Refer also to abstracts 17362, 17364, and 18099.

17728 (EUR-4736, pp 103) PRACTICAL MONITORING OF A WASTE STORAGE SITE. Krause, H. 1970.

From Conference on health implications of the storage of radioactive substances on and in the ground; Cherbourg-La Hague, France (14 Apr 1970).

Radiation monitoring programs to assure that the operation of an underground radioactive waste storage facility is not contaminating the environment are briefly discussed. (L.C.L.)

17729 PREOPERATIONAL RADIOLOGICAL SURVEILLANCE OF THE FLORIDA POWER CORPORATION'S CRYSTAL RIVER POWER REACTOR SITE. Nayfield, Chester L.; Johnson, Wallace; Prewitt, Benjamin P. (Florida Division of Health, Orlando). Radiol. Health Data Rep.; 12: No. 9, 441-9(Sep 1971).

Preoperational radiological surveillance has been conducted by the Florida Division of Health around the Crystal River nuclear power generating plant site since May 1969. A summary of these data with reference to statistically significant differences between sampling locations is presented, and comparisons are made with data from other locations in the State. (auth)

17730 HIGH TEMPERATURE MEASUREMENTS OF THE RATES OF UPTAKE OF MOLYBDENUM OXIDE, TELLURIUM OXIDE, AND RUBIDIUM OXIDE VAPORS BY SELECTED OXIDE SUBSTRATES. Adams, Charles E.; Quan, Jack T.; Balkwell, William R. (Naval Radiological Defense Lab., San Francisco). Advan. Chem. Ser.; No. 93, 35-62(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

The rates of uptake of molybdenum, tellurium, and rubidium oxide vapors by substrates of calcium ferrite and a clay loam have been measured in air over a temperature range from 900 to 1500°C and a partial pressure range of about 10^{-7} to 10^{-4} atm. The measured rates of uptake of molybdenum and tellurium oxide vapors by molten calcium ferrite and of rubidium oxide vapor by both molten clay loam and calcium ferrite were controlled by the rates of diffusion of the oxide vapors through the air. The measured rates of uptake of molybdenum and tellurium oxide vapors by molten clay loam were controlled by a combination of a slow surface reaction and slow diffusion of the condensate into the substrate. (auth)

17731 DEUTERIUM CONTENT OF PEAT AS A PALEOCLIMATIC RECORDER. Schiegl, W. E. (Council for Scientific and Industrial Research, Pretoria). Science; 175: No. 4021, 512-13(4 Feb 1972).

During the transformation of vegetable matter into peat the initial deuterium concentration decreases systematically with increasing carbon content. From this relationship the original deuterium content of the plants that formed the peat in Dutch peat bogs can be derived, and the values obtained can be correlated with past summer temperatures in the Netherlands. (auth)

17732 LIMITED REMOVAL OF ^{210}Po AND ^{210}Pb FROM SOIL AND FERTILIZER BY LEACHING. Tso, T. C. (Dept. of Agriculture, Beltsville, Md.). Agron. J.; 62: No. 5, 663-4(Sep-Oct 1970).

The radioelements ^{210}Po and ^{210}Pb are known to be present in plants. They enter the plants primarily by root absorption. Heavy and continued fertilization increases the level of radioelements in soil and thus in crops so produced. Results obtained from laboratory experiments show that there is limited removal of ^{210}Po and ^{210}Pb by leaching from soil or from fertilizer. Mechanical agitation appeared to increase the leaching rate of these elements. Generally, ^{210}Po was leached from soil or from soil-fertilizer mixture much easier than ^{210}Pb, with or without agitation. (auth)

17733 FACTORS INFLUENCING THE MOVEMENT AND FIXATION OF ^{90}Sr IN THE SOIL. Darab, K.; Toeroek, I. (National Inst. of Agricultural Quality Testing, Budapest). Agrokem. Talajtan; 20: No. 1-2, 147-56(Jun 1971). (In Hungarian).

The ^{90}Sr contamination of 11 soils of different types and textures was studied. The soils examined were humous sand, meadow soil, and different types of salt-affected soils having textures varying widely from silty sand to heavy clay. The total Ca content in the soils and in their colloid fractions was also different. In the salt-affected soils there were differences in the total salt contents, ESP values, and the soluble salt compositions. The areas represented by the samples examined were partly under grassland partly under agricultural cultivation. One sample was taken from a rice field. The ^{90}Sr was determined by the oxalate method, after extraction with hydrochloric acid; the activities are given in mCi/km^2. According to the results it can be stated that in salt affected soils the fixation and mobility of ^{90}Sr depends on the alkalinity, on the relative amount of exchangeable Na ions (ESP), and the quantity and chemical composition of the soluble salts. The higher alkalinity of the soils' liquid phase, the lower solubility and mobility of the Ca compounds in the soil, the more intense accumulation of ^{90}Sr in the uppermost soil layers (of some cm) and higher Sr-fixation. Due to the particular water regime and chemical properties of the salt affected soils, the texture has only a second-hand role in the degree and form of strontium fixation which are influenced first by the degree of salinity and alkalinity. In non-cultivated soils, the radioactive contamination occurs mainly in the some cm thick top layer. As a result of mechanical mixing, the ^{90}Sr contamination of arable lands is uniformly distributed in the ploughed layer. By the reclamation of salt affected soils, the radioactive contamination of the top layer can be reduced and the leaching of fission products can be promoted by increasing the solubility of Ca compounds in the soil and, at the same time, the concentration of Ca^{2+} ions in the soil solution. When $CaCO_3$ and $CaSO_4$ are not present in considerable amounts in the soil, the mobility of ^{90}Sr can be increased by the application of calcium containing chemical amendments. Beside increasing the Ca^{2+} ion concentration in the soil solution, the possibilities of a better downward water movement and leaching are also to be promoted by eventual irrigation. (auth)

Water

Refer also to abstracts 17357-17361, 17368, 17402, and 18405.

17734 DATA, SECTION II, WATER. Radiol. Health Data Rep.; 12: No. 9, 471-7(Sep 1971).

Descriptions and results of water sampling activities conducted to monitor gross radioactivity in surface waters in the US during January 1971, and radioactivity in New York surface waters from July 1969 through June 1970 are presented. (J.R.D.)

17735 PLUTONIUM IN THE WATER ENVIRONMENT. I. CHARACTERISTICS OF AQUEOUS PLUTONIUM. Andelman, Julian B.; Rozzell, Thomas C. (Univ. of Pittsburgh). Advan. Chem. Ser.; No. 93, 118-37(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

In the pH range of natural waters colloidal plutonium(IV) hydroxide forms from polymeric hydrolysis products and ages slowly. At least over a period of several days an increase in particle sizes is observed. At pH 7 such solutions aged for a few months showed a significant increase in size of the colloidal plutonium as the ionic strength increased from 0.002 to 0.1. The centrifugability of the colloid, aged for three and seven days at pH 7, decreased for plutonium concentrations less than 10^{-7} M. The addition of macroscopic grains of crystalline silica affected the colloidal plutonium size distribution as did the variation in pH over the range of 5 to 8. The addition of 10^{-2} M bicarbonate ions at pH 7 also influenced the distribution but less systematically. (auth)

17736 SIMULATION OF THE HYDROLOGIC TRANSPORT OF RADIOACTIVE AEROSOLS. Huff, Dale D.; Kruger, Paul (Stanford Univ., Calif.). Advan. Chem. Ser.; No. 93, 487-505 (1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

A model for the hydrologic transport of radioactive aerosols has been prepared to simulate watershed radioaerosol hydrographs. The hydrologic transport model (HTM-1) is based on the anticipated physical and chemical interactions of fallout-deposited radioaerosols with watershed media during runoff. A numerical simulation of the watershed moisture balance is computed by the Stanford watershed model and is used to estimate resulting effects on radioaerosol transport. Transport calculations consider the effects of vegetal interception, soil surface interactions (including erosion), and stream channel movement to predict a continuous radioaerosol hydrograph for the two biologically important radionuclides: 27.7-year ^{90}Sr and 30.0-year ^{137}Cs. Experimental radioaerosol hydrographs have been obtained for the Saratoga Creek, Calif., watershed. These data are used to evaluate the several processes considered in preparing the HTM-1. (auth)

17737 DATA, SECTION II, WATER. Radiol. Health Data Rep.; 12: No. 10, 511-19(Oct 1971).

Descriptions and results of water sampling activities conducted to monitor gross radioactivity in surface waters in US during February 1971, radioactivity in California waters during 1969, and radiostrontium in New York City tap water from July through December 1970 are presented. (J.R.D.)

17738 RADIOACTIVITY OF WATER-SOURCES OF SOME CRYSTAL MASSIFS OF GEORGIA. Meladze, G. K. Soobshch. Akad. Nauk Gruz. SSR; 65: No. 1, 93-6(Jan 1972). (In Georgian).

Comparatively highly radioactive springs of the crystal massifs of Georgia (Dzirula, Khrami, and Merisi) are morphologically connected with acid crystal clefts, tectonic faults, hydrothermally changed contact-metamorphic zones, and their drift beds. The increased radioactivity is caused by radioactive elements scattered in the main rock-forming and accessory minerals, high emanation capacity of rocks, and existence of enriching collectors. This is conditioned by hypergenetic factors and their consequent processes, not being connected with more or less substantial accumulation of uranium or radium. (auth)

Ecosystems and Food Cycles

Refer also to abstracts 17365, 17367, 17369, 18083, and 18099.

17739 (HASL-246, I.18-44) ANALYSES OF QUALITY CONTROL SAMPLES AT HASL AND A CONTRACTOR LABORATORY DURING 1971. Hardy, E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Samples of biological material and fallout, analyzed at HASL and by a contractor laboratory include quality control samples which are submitted as blinds. The checks consist of blanks, natural samples analyzed repeatedly from year to year, replicates or splits of unknown, spikes, and duplicate samplings. Quality control data for ashed bone, diet, and fallout samples analyzed for ^{90}Sr, ^{89}Sr, ^{137}Cs, and Ca during 1971 are reported. (auth)

17740 (HASL-246, I.45-52) STABLE LEAD CONCENTRATIONS IN NEW YORK CITY FOODSTUFFS. Bogen, D. C. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Nineteen food categories which constitute the typical American diet have been analyzed for stable lead. Three complete diet samplings are reported. The dietary intake of lead obtained from the first study was about 285 μg/day, while the intake from the other two studies was between 70 and 80 μg/day. The higher results obtained for the first study are suspect because of possible contamination. (auth)

17741 (HASL-246, I.107-22) ESTIMATION OF ^{90}Sr LEVELS IN THE DIET. Bennett, B. G. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

From the long term HASL programs of ^{90}Sr deposition measurement and analysis of ^{90}Sr in milk and total diet in New York City, methods have been developed for making reliable estimates of ^{90}Sr levels in milk and total diet. The deposition-milk relationship includes a lag term to account for use of stored feed and exponential removal of the contribution from deposition of preceding years. Exponential removal, to account for decay and reduced uptake availability of ^{90}Sr in soil, amounts to 13% per year in New York. The diet-milk ratio, commonly used to estimate dietary intake of ^{90}Sr from ^{90}Sr intake in milk, varies considerably for New York and would be expected to vary similarly in other areas through periods of changing deposition. Improvements in dietary ^{90}Sr intake estimates are achieved by using quarterly milk measurements and estimating ^{90}Sr intake in non-dairy foods from the ^{90}Sr intake in milk in the preceding quarter. (auth)

17742 RADIONUCLIDES OF HYDROBIONTS. Polikarpov, G. G. Priroda; No. 10, 47-55(Oct 1971). (In Russian).

A cursory survey of the impact of radioactive materials on marine organisms is given. The dynamics of accumulation of ^{91}Y, ^{144}Ce, and ^{204}Tl by certain marine organisms is presented graphically and discussed, employing the concepts of the coefficients of absorption and accumulation, respectively. The accumulation and distribution of radionuclides in organisms is considered in connection with bioindicators and bioconcentrators. The topic of worldwide radioactive contamination of the hydrobiosphere by ^{90}Sr is presented with illustrations, and the increase of ^{90}Sr concentration in organisms considerably above the ^{90}Sr concentration in water is noted for higher members of the food chain. (K.S.W.)

17743 ^{137}Cs IN THE FLESH OF IMPORTANT MEAT PRODUCING ANIMALS IN NORWAY. Espeland, K. G. (Institutt for Farmakologi og Toksikologi, Oslo). Norsk Vet.-Tidsskr.; 83: No. 5, 322-8(1971). (In Norwegian).

Measurements of ^{137}Cs in meat from important meat producing animals in Norway were carried out at the Norwegian Defence Research Establishment during 1959 to 1970. The measurements showed that the highest concentrations were found in reindeer. The concentrations in sheep and goats were considerably lower, and the lowest was found in cattle, horses, and pigs. The highest concentrations were measured in 1963 and 1965 to 1966. Since then a gradual decrease was recorded. The relative reduction was lowest in the species that show the highest values. Reindeer were more strongly contaminated in the spring than in the autumn, while the other species show the opposite pattern. Sheep show the relatively highest seasonal variation. Variations were also recorded with regard to various geographical, climatic, depositional, feeding, and grazing conditions. (auth)

17744 ^{239}Pu, ^{90}Sr, AND ^{137}Cs: CONCENTRATIONS IN HUMAN ORGANS OF THE JAPANESE. Takizawa, Yukio (Niigata Univ., Japan); Sugai, Ryuichi. Arch. Environ. Health; 23: No. 6, 446-50(Dec 1971).

The dynamic aspects of the selective accumulation of radioactive nuclides such as plutonium-239, cesium-137, and strontium-90 are reported. The survey proceeding the Japanese atomic explosion has revealed considerable increase in the amount of fallout. The possible hazards and the need to evaluate the contamination are considered. (auth)

17745 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 12: No. 9, 483-90(Sep 1971).

Results of routine sampling of biological and other materials are presented. Included are data on ^{90}Sr in human bone and radioactivity at atomic energy installations. (J.R.D.)

17746 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 12: No. 9, 459-70(Sep 1971).

Data and information on milk surveillance in the western hemisphere during May 1971 are presented. It is noted that fission products most commonly found in milk are ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs and ^{140}Ba. Naturally occurring ^{140}K is also present. Discussions are included on accuracy of reported data, development of common reporting bases, data reporting formats, evaluation of current data, and food and diet surveillance. (J.R.D.)

17747 EVALUATION OF THE SAMPLING FREQUENCY OF THE PASTEURIZED MILK NETWORK. Stein, John L. (Anheuser-Busch, St. Louis); Jaquish, Richard E.; Sharpe, Thomas J. Radiol. Health Data Rep.; 12: No. 9, 451-5(Sep 1971).

The Pasteurized Milk Network (PMN) of the Environmental Protection Agency reduced its milk sampling frequency from weekly to monthly in July 1970. A review of the effects of this reduced sampling frequency from a statistical viewpoint, on the capability of the network to carry out the surveillance requirements outlined by guides of the Federal Radiation Council was conducted. Results of the study showed that, based on the presently accepted radiation protection guides, the reduced frequency of milk collection does not sacrifice the precision required for a public health evaluation of current levels of radionuclides in the nation's pasteurized milk supply. (auth)

17748 DECREASE OF BOVINE ^{137}Ce CONCENTRATIONS FOLLOWING THE CESSATIONS OF ATMOSPHERIC NUCLEAR WEAPONS TESTING. Blincoe, Clifton; Bohman, V. R. (Univ. of Nevada, Reno). Advan. Chem. Ser.; No. 93, 427-35(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Cattle have been used since 1958 to study the fallout ^{137}Cs concentration in the biosphere. These studies have been made at three locations in Nevada and have included measurement of both liver and skeletal muscle concentrations of ^{137}Cs twice yearly. A comparison of yearling and mature cattle indicated no effect of these ages at slaughter on the ^{137}Cs concentration. The half-period for decrease of bovine soft-tissue ^{137}Cs in the absence of atmospheric nuclear weapons testing averaged 0.9 year (0.5 ± 0.1 to 1.3 ± 0.5 years). There was no significant difference in the rate of decrease following the cessation of atmospheric nuclear weapons testing in 1959 and in 1963. The same rate of decrease was observed at all three locations and in both muscle and liver. (auth)

17749 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 12: No. 10, 501-10(Oct 1971).

Data and information on milk surveillance in the western hemisphere during June 1971 are presented. It is noted that the fission products most commonly found in milk are ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba. Naturally occurring ^{140}K is also present. Discussions are included on accuracy of reported data, development of common reporting bases, data reporting formats, and evaluation of current data. (J.R.D.)

17750 JOINT X-RAY RADIATION SURVEY IN PUERTO RICO, 1968. Gileadi, Michael (Puerto Rico Nuclear Center, Mayaguez). Radiol. Health Data Rep.; 12: No. 10, 495-9(Oct 1971).

The objectives, scope, and methods used in the 1968 Joint Radiation Survey Project, sponsored by the Puerto Rico Nuclear Center and by the Department of Health of the Commonwealth of Puerto Rico, are described. The most significant results concerning the western and southern regions of the island are presented. Most of the three quantifiers (mean gonadal dose, per capita per annum gonadal dose, and genetically significant dose) were smaller in the southern region than those in the western region. (auth)

17751 UPTAKE OF RADIONUCLIDES BY I-GROUP PLAICE (PLEURONECTES PLATESSA) OFF THE CUMBERLAND COAST, IRISH SEA. Pentreath, R. J.; Jefferies, D. F. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). J. Mar. Biol. Ass. U.K.; 51: No. 4, 963-76(1971).

The accumulation of radionuclides by I-group plaice, Pleuronectes platessa L, in the vicinity of the pipeline of the UKAEA plant at Windscale, Irish Sea, was studied over a 7-month period. The principal isotope found in the flesh was ^{137}Cs, although ^{144}Ce, ^{106}Ru, and $^{95}Zr/^{95}Nb$ were also present in the gut contents. The ^{137}Cs flesh levels were examined in conjunction with the fluctuations of this nuclide in sea water, sediment and the gut contents. Of the three major dietary components found throughout the sampling period the calculated intake of ^{137}Cs from food appeared to fluctuate most closely with the Nephtys fraction of the diet, despite its relatively low ^{137}Cs content. (auth)

17752 ^{137}Cs IN PLACENTAE, URINE, FOOD, AND RAIN IN HIROSHIMA. Takeshita, K. (Hiroshima Univ.); Antoku, S.; Sunayashiki, T.; Tabuchi, A. Health Phys.; 22: No. 3, 251-6(Mar 1972).

Chemical analysis of ^{137}Cs levels in placentae, postpartum urine, diet, milk and rainwater has been conducted since 1966. In spite of seasonal changes with generally lower levels in summer than in winter, monthly averages decreased year by year. Body burdens were estimated to be 3 nCi in 1966, with a gradual decrease to less than 1 nCi in 1969. (auth)

Radiometric Techniques

Refer also to abstracts 17371, 17401, 17429, 17551, 17857, and 17858.

17753 (RT/GEO-(70)14) DEVELOPMENT OF NUCLEAR METHODS FOR MEASURING DENSITY AND NATURAL WATER CONTENT OF SOILS. Cotecchia, V.; Pirastru, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1970. 28p. (In Italian). (CONF-701061-1). Dep. NTIS (U. S. Sales Only).

From tenth conference on geological techniques; Bari, Italy (26 Oct 1970).

The studies conducted since 1961 to investigate and eliminate interference affecting measurement of the density and natural water content of soils by the nuclear method are reported. By means of studies made on the basis of neutron transport and diffusion theories it has been possible to obtain a complete picture of the way in which the measurement of the natural water content is influenced by chemical composition and dry density of the soil. The information thus obtained was applied to build an original epithermal neutron probe incorporating a special helium-3 counter. This is not influenced by chemical composition and is particularly insensitive to the presence of such elements as chlorine, boron and cadmium, which are well known for their interference in the case of measurements run with the usual types of thermal neutron probes. Regarding density measurements, numerous experiments and theoretical studies have clarified the role played by interference which is particularly marked in boreholes with aluminum or plastic casings. The interference effect has been reduced to acceptable values by eliminating the lower-energy back-scatter radiation by placing filters around the Geiger–Mueller counters. Also investigated was the problem of the interference produced by the extent to which the atomic number/atomic weight ratio of each element varies from the value, 0.5. It has been ascertained that the phenomenon is only likely to be particularly marked where hydrogen is concerned; however with a neutron probe it is possible to determine the quantity of hydrogen present and thus make allowance for interference from this source by reading the adjusted results from appropriate calibration curves. A review is presented of the fields to which the use of neutron and gamma ray probes have been extended; measurement of the chlorine content in ground waters, measurement of the flow rate of ground waters by using certain stable tracers (cadmium and boron), measurement of total and partial porosity of soils, and measurement of suspended load in rivers, and of the density of materials newly deposited in lakes. (auth)

17754 GEOCHEMISTRY OF THREE CORES FROM THE EAST PACIFIC RISE. Bender, Michael; Broecker, Wallace; Gornitz, Vivian; (and others) (Columbia Univ., Palisades, N. Y.). Contract AT(30-1)-3139. Earth Planet. Sci. Lett.; 12: No. 4, 425-33(Dec 1971).

We have determined sedimentation rates of a core from the crest and two cores from the flank of the East Pacific Rise from the depth variations of their excess ^{230}Th content. We have also analyzed composite strip samples from these three cores for [Mn], [Fe], [Ni], [SiO_2], [Al_2O_3], [NaCl], and mineralogy, and determined the rare earth contents and isotopic composition of lead, strontium, and uranium in the crest core. The Mn accumulation rate of the crest core is 25 times higher than the world average, supporting the conclusion of Bostrom and Peterson [1] that at least some of the elements in these sediments derive from local volcanism. The relative concentrations of the rare earth elements and the isotopic composition of U and Sr in the crest core indicate that these elements derive from seawater. On the other hand, the isotopic composition of lead in the crest core indicates that the lead is mostly of local volcanic origin. (auth)

17755 STABLE CARBON ISOTOPE RATIOS WITHIN CARBONATE CONCRETIONS: A CLUE TO PLACE AND TIME OF FORMATION. Curtis, C. D.; Petrowski, C.; Oertel, G. (Univ. of California, Los Angeles). Nature (London); 235: No. 5333, 98-100(14 Jan 1972).

A review is presented of studies made on the variability of the $^{13}C/^{12}C$ ratio in naturally occurring carbon. This ratio in plant material is in general about 2.5% lower than in the carbonate of marine limestones, as a result of fractionation during photosynthesis, and some sedimentary iron carbonates have been found to be unusually rich in ^{13}C. The conclusions from research on the subject are to some extent in conflict, some indicating correlation between isotopic composition and deposition environment and others indicating that bacterial processes tend to control ratios, which are not indicative of environment. Investigations of a siderite concretion from the European Carboniferous suggested that diagenetic concretion growth occurs in two distinct stages: an early period of rapid growth within essentially uncompacted sediment is followed by a protracted second phase spanning the full compactional history of the enclosing sediment. The present communication describes an investigation of the distribution of stable carbon isotopes within various siderite concretions. Details are given of the experimental methods employed, and results are discussed. Some studies on clay sediments are also described. (UK)

17756 DETERMINING FORMATION PERMEABILITY BY MEANS OF REPEATED FLUID INJECTIONS AT DIFFERENT PRESSURES AND AFTER EACH INJECTION PRODUCING A NEUTRON ACTIVATION LOG. Wyman, Richard E. (to Shell Oil Co.). U. S. Patent 3,628,011. 14 Dec 1971. Filed 14 Aug 1969.

A method for determining the permeability of a formation penetrated by a well using a neutron decay logging procedure is described. An aqueous liquid having a known neutron-capture cross section is first injected into the formation until the water saturation of the formation of interest is substantially 100%. Following the aqueous liquid, a viscous liquid having a known neutron-capture cross section which is different from the cross section of the aqueous liquid is injected at a low pressure. When equilibrium is reached, the concentration of the viscous liquid is measured using a neutron decay logging procedure. The injection of the viscous liquid is repeated using a higher pressure and the concentration of viscous liquid again measured. The injection pressure is increased in discrete steps and the concentration measured for each step until the fracturing pressure of the formation is approached. The concentration of viscous liquid versus injection pressure is plotted and used to determine the permeability of the formation. (Official Gazette)

Site Surveys

Refer also to abstracts 17693, 17754, 18407, 19751, 19758, 19800, and 19808.

17757 (ARMS-68,6,9) AERIAL RADIOLOGICAL MEASURING SURVEYS OF THE NUCLEAR FUEL SERVICES PLANT, WEST VALLEY, NEW YORK, 1968 AND 1969. Barasch, Guy E.; Beers, Richard H. (EG and G, Inc., Goleta, Calif.). Apr 1971. 39p. (EGG-1183-2235). Dep. NTIS.

Two Aerial Radiological Measuring surveys, made in October 1968 and September 1969, of the 600 square mile area surrounding the Nuclear Fuel Services plant in West Valley, New York, were

analyzed and reported. Within the primary fenced boundaries of the facility, which include a fuel-processing plant and high-level waste burial grounds, the ground exposure rates inferred from the airborne gamma count rate measurements were approximately 100 μR/hr during the 1968 survey and approximately 1 mR/hr during the 1969 survey. These measurements, which are averages over an approximately 1200-ft-dia effective field of view, are consistent with the concurrent plant operations. The primary sources of observed radiation were ^{137}Cs, ^{134}Cs, and ^{60}Co, and the other nuclides known to be present were of insufficient additional intensity to be observed. Within the secondary fenced boundaries, ^{137}Cs and ^{134}Cs gamma radiation was detected along a system of waterways used for low-level liquid waste disposal, at sufficient intensity in places to exceed the background count rate by up to a factor of three. Concentrations of water-borne cesium in these streams have been measured by other investigators and are 1000 times too small to produce the radiation levels observed from the ARMS aircraft. A mechanism in which the radioactivity is strongly concentrated in the exposed silt material surrounding the streams is shown to be capable of explaining the observed radiation levels. (auth)

17758 (DOCKET-50201-105) WEST VALLEY REPROCESSING PLANT. Tornado Missile Analysis Supplement. (Nuclear Fuel Services, Inc., Rockville, Md.). 20 Jan 1972. 9p. Dep. NTIS.

The analysis concerns a one-inch diameter steel bar weighing 8 pounds with a velocity of 250 feet per second and the vertical velocity of one of the previous missiles, a 4 × 12 × 10 ft plank weighing 110 pounds with a horizontal velocity of 330 feet per second. (M.C.G.)

17759 (EUR-4736, pp 79-87) SITING OF STORAGE FACILITIES FOR RADIOACTIVE WASTE. Grison, G. (European Communities, Luxembourg. Commission). 1970.

From Conference on health implications of the storage of radioactive substances on and in the ground; Cherbourg-La Hague, France (14 Apr 1970).

A method for selecting sites for radioactive waste storage in the Euratom Community is described. Essentially this graphic method consists of a series of translucent maps showing the geography of the area. Each map represents a parameter related to waste disposal. These parameters include: population density (which also reflects the economic value of land on the site); meteorological conditions; geology; soil permeability; hydrogeology; and seismic activity. Each map is color-shaded with the lightest tones representing the most desirable areas as that parameter relates to waste disposal. Overlaying the maps combines the parametric effects and results in light-colored zones which indicate the best areas for waste disposal. The darkest zones represent areas in which no disposal should be considered. (L.C.L.)

17760 (EUR-4736, pp 87-9) ESTABLISHMENT OF A RADIOACTIVE WASTE DISPOSAL SITE. Krause, H. 1970.

From Conference on health implications of the storage of radioactive substances on and in the ground; Cherbourg-La Hague, France (14 Apr 1970).

A brief discussion is presented of factors to be considered in selecting a site for above- or below-ground radioactive waste storage. These factors are enumerated as: characteristics of the waste; transportation aspects; site storage capacity; environmental contamination or public health effects; and phychological aspects, i.e., acceptance by the public. (L.C.L.)

17761 (EUR-4736, pp 104-16) SURVEILLANCE OF THE RADIOACTIVE WASTE DISPOSAL SITE AT LA HAGUE (MANCHE CENTRE). Scheidhauer, J. 1970.

From Conference on health implications of the storage of radioactive substances on and in the ground; Cherbourg-La Hague, France (14 Apr 1970).

The program for radiation monitoring of the atmosphere, and ground and surface waters near the solid radioactive waste disposal site at La Hague (Manche Center) is briefly described. (L.C.L.)

17762 (SWRHL-71-r) OFF-SITE RADIOLOGICAL SURVEILLANCE, NIMBUS B-2/SNAP-19 LAUNCH, APRIL 13, 1969. (Western Environmental Research Lab., Las Vegas, Nev.). Dec 1971. 9p. Dep. NTIS.

The Western Environmental Research Laboratory provided off-site surveillance for the successful launch of the Nimbus B-2/SNAP-19 weather spacecraft on April 13, 1969. Environmental monitoring and samples taken before and after the launch indicated no release of radioactivity. (auth)

17763 (USGS-474-122) RADIOCHEMICAL ANALYSES OF WATER FROM SELECTED STREAMS AND PRECIPITATION COLLECTED IMMEDIATELY BEFORE AND AFTER THE SECOND PRODUCTION-TEST FLARING, PROJECT RULISON. Rulison-10. Claassen, Hans C. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 10p. (PNE-R-56). Dep. NTIS.

Data on the tritium content of stream and precipitation samples collected in conjunction with the second production flaring (Dec. 1 to 20, 1970) are reported, and the published data through Dec. 22, 1970, are updated. The location of the network sampling points are given. (P.C.H.)

17764 (USGS-474-139) MARINE TERRACES OF THE WESTERN ALEUTIAN ISLANDS, ALASKA. Morris, Robert H. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 26p. Dep. NTIS.

The islands of the Rat Islands group, which includes Amchitka Island, have active sea cliffs, well-developed intertidal platforms, and a prominent submarine platform at −100 m. These features have not been disturbed by tectonic activity for the past 17,000 years. The islands of the Delarof Islands group, located east of Amchitka Pass, have inactive sea cliffs and emergent low terraces that indicate relatively recent uplift, possibly as much as 4 m. Higher and older marine terraces on the islands of both groups cannot be correlated, and some tectonic adjustment between the island groups is suggested. (auth)

17765 (WASH-1501) UNDERGROUND NUCLEAR TEST PROGRAMS. NEVADA TEST SITE (TESTS OF ONE MEGATON OR LESS). Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Sep 1971. 88p. Dep. NTIS.

The environmental impact of continuing underground nuclear tests and preparations for tests of one megaton or less at the Nevada Test Site (NTS) is reported. Information is included on the selection, geology, hydrology, environmental setting, and history of the NTS; the seismic and radiological impact of underground nuclear explosion testing; the commitment of resources; alternatives to testing; and review procedures. Two appendixes of bioenvironmental studies of the NTS and comments by the AEC and other agencies on the environmental impact report are included. It is concluded that the environmental impact due to continued testing at the NTS will be small. No observable or significant environmental effects are expected from radioactivity release. The explosions will create several nuclear subsidence craters, minor rock falls on cliffs in the area, and underground pockets of high radioactivity, but only minor property damage from ground motions and no triggering of earthquakes. The benefits to nuclear weapons technology and Plowshare technology from continued underground testing are considered to exceed the environmental costs. (L.C.L.)

17766 (WASH-1508) REACTOR TESTING: FY 1972. NUCLEAR ROCKET DEVELOPMENT STATION, NEVADA. Environmental Statement. (Atomic Energy Commission, Washington, D. C. National Aeronautics and Space Administration, Washington, D. C.). Dec 1971. 86p. Dep. NTIS.

This final environmental statement is issued jointly by the AEC and NASA in accordance with the National Environmental Policy Act and the implementing guidelines of the Council on Environmental Quality and in support of proposed administrative action to continue nuclear rocket ground development testing. It takes into account all comments received on the draft statement issued in July 1971. A program managed by the joint AEC-NASA Space Nuclear Systems Office has been underway since 1955 to realize the potential inherent in nuclear rockets. Testing of materials, fuel elements, and design concepts is essential to progress and nineteen (19) experimental reactors and engines have been ground tested to date at the Nuclear Rocket Development Station (NRDS) in Nevada. These years of testing demonstrated the feasibility of nuclear rockets. Nuclear rocket testing is now in an essential development stage with the goal of providing a reliable, reusable, long-lived flight engine. In this connection, a new type of reactor concept, the Nuclear Furnace, has evolved which will permit individual fuel element testing in a realistic thermal and neutronic environment at only one fortieth of the power of a full scale reactor. It is proposed to perform tests using this type of reactor at NRDS during FY 1972 and 1973. In addition, methods of providing various facility equipment to reduce fission product release were explored and resulted in the adoption of effluent gas and liquid waste cleaning systems which are expected to be very effective and result in minimal environmental impact. However, there is expected to be an unavoidable release of small quantities of radioactivity which is not expected to exceed 2 to 4% of the Federal Radiation Council guidelines; possible biological effects on fish and wildlife are not considered significant; population density or

distribution will not be affected; and land utilization will be minimal and reversible and will not preclude the use of the site for other purposes after the termination of the proposed operations. In balancing the benefits of fuel element testing with the Nuclear Furnace during FY 1972 and 1973 against the environmental costs described above, and considering the alternatives available, the U. S. Atomic Energy Commission and the National Aeronautics and Space Administration have concluded that the proposed course of action should be implemented. (auth)

17767 (WASH-1511(Dr.)) STORAGE OF RADIOACTIVE WASTE IN BEDROCK SUBSURFACE EXPLORATION, SAVANNAH RIVER PLANT, AIKEN, SOUTH CAROLINA. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 38p. Dep. NTIS.

The environmental impact of a proposed subsurface exploration for determining the characteristics of bedrock near the Savannah River Plant (SRP) is reported. The long-term storage in this bedrock of high-level liquid wastes from the fuel reprocessing facility is being considered. The exploration activities which would affect the environment include clearing a construction site, sinking a vertical access shaft, and deposition of rocks, sediments, and water from the excavation. Fifty-five acres of replantable pine plantation might be affected. Only a small fraction of this would be involved in locating permanent surface facilities. By isolation of aquifers during shaft construction and by careful control of excavated water and solids to prevent soil erosion, minimal disturbance of existing hydrologic and geologic conditions and plant and animal growth is envisioned. There are no alternatives to this project which would permit a decision on the safety of the bedrock waste disposal concept. (L.C.L.)

17768 (WASH-1519(Dr.)) RIO BLANCO GAS STIMULATION PROJECT, RIO BLANCO COUNTY, COLORADO. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 170p. (PNE-RB-1). Dep. NTIS. $10.03.

The environmental impact of the proposed Rio Blanco Project for nuclear stimulation of natural gas reserves in Colorado is reported. Information is included on: the project background and description; probable impact on the environment of project construction, ground motion and underground explosions effects, release of radioactive gases, and waste management; containment of explosion, ground water contamination; mineral resources; alternatives to project; commitment of resources; and costs. 48 references are cited. Four Appendixes are included on environmental setting, seepage model, preliminary report on hydrologic testing, and geologic faults and joints in the region. After review of all the environmental considerations related to the proposed Rio Blanco experiment, it is concluded that the experiment will cause minor adverse effects on the local environment, including ground-motion damage to local man-made structures, brief disruption in the daily routine of local residents at the time of the detonation, and possible exposure of local residents to very low levels of radioactivity during production testing. The likelihood of an accidental release of significant amounts of radioactivity to overlying aquifers or to the atmosphere is considered to be so highly improbable as to constitute no real risk to the environment. The Rio Blanco experiment will not adversely affect the future recoverability of the valuable minerals contained in the local oil shales overlying the detonation area. In assessing and balancing the potential value of the natural gas contained in low-permeability reservoirs of the Rocky Mountain region and the Nation's apparent serious need for supplementary energy sources in the next ten to thirty years against the costs involved and in considering the available alternatives, it is concluded that the proposed Rio Blanco project is the best available alternative and that the benefits of the proposed action outweigh its probable environmental costs. (auth)

17769 (WASH-1524(Dr.)) WAGON WHEEL GAS STIMULATION PROJECT, SUBLETTE COUNTY, WYOMING. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 109p. (PNE-WW-3). Dep. NTIS.

The environmental impact of the proposed Wagon Wheel Project for nuclear stimulation of natural gas reserves in Wyoming is reported. Information is included on: the project background and description; probable impact of site construction, underground explosion effects, release of radioactive gases, and waste disposal; contamination of containment cavity and ground waters; alternatives to project; commitment of resources; and costs. Appendixes of 40 references and data on the environmental setting and a seepage model are included. After review of all the environmental considerations related to the proposed Wagon Wheel experiment, it is concluded that the experiment will cause minor adverse effects on the local environment, including ground-motion damage to local man-made structures, relatively brief disruption in the daily routine of local residents at the time of the detonation, and possible exposure of local residents to very low levels of radioactivity during production testing (about 1 mrem). The likelihood of an accidental release of significant amounts of radioactivity to overlying aquifers or to the atmosphere is considered to be so highly improbable as to constitute no risk to the environment. In assessing and balancing the potential value of the natural gas contained in low-permeability reservoirs of the Rocky Mountain region and the Nation's apparent serious need for supplementary energy sources in the next ten to thirty years against the costs involved and in considering the available alternatives, it is concluded that the proposed Wagon Wheel project is the best available alternative and that the benefits of the proposed action outweigh its probable environmental costs. (L.C.L.)

Thermal Effluents

Refer also to abstracts 18407 and 19797.

17770 (HEDL-TME-71-165) ENVIRONMENTAL ENGINEERING PROGRAMS. Quarterly Technical Progress Report, July-September 1971. Bailey, G. F. (comp.) (Hanford Engineering Development Lab., Richland, Wash.). Nov 1971. Contract AT-(45-1)-2170. 45p. Dep. NTIS.

Research progress is reported on simulation modeling of environmental effects of thermal generation, regional modeling of surface water temperature from projected power growth, and engineering evaluation of environmental aspects of nuclear plants. (J.R.D.)

17771 (TID-25902) COLUMBIA RIVER THERMAL EFFECTS STUDY. VOLUME I. BIOLOGICAL EFFECTS STUDIES. (Environmental Protection Agency, Seattle, Wash.). Jan 1971. 102p. Dep. NTIS.

Studies on the biological effects of water temperature on Pacific anadromous fish in the Columbia River system are reported. The results showed that many variables influence the thermal tolerance of Pacific salmon. However, within broad ranges, the fisheries agencies of the Pacific Northwest have recommended optimum temperatures that are conducive to the production of fish resources in the Columbia Basin. These ranges are: 45 to 60°F (7.2 to 15.6°C) for migration routes; 45 to 55°F (7.2 to 12.8°C) for spawning areas; and 50 to 60°F (10 to 15.6°C) for rearing areas. A discussion on the general effects of temperature on aquatic life is also included. (148 references) (P.C.H.)

17772 (TID-25903) COLUMBIA RIVER THERMAL EFFECTS STUDY. VOLUME II. TEMPERATURE PREDICTION STUDIES. (Environmental Protection Agency, Seattle, Wash.). Jan 1971. 64p. Dep. NTIS.

The application of mathematical models to the Columbia River for prediction of water temperatures is described. Three numerical models have been adapted to predict temperatures in the main stem Columbia River, extending 750 miles from the Canadian border to the mouth of the river at Astoria, Oregon. These three models facilitate prediction of temperatures in the four hydraulic regimes which comprise the main stem Columbia in the U. S. The three models are the weakly stratified reservoir model, the river-run reservoir model, and the estuary model. The hydrology, meteorology, and geography of the Columbia River basin and water temperature regime of the Columbia, Snake, and Willamette Rivers are discussed and various conclusions and recommendations are given. (P.C.H.)

17773 CLEANING OF AMERICA. Williams, Laurence O. (Martin Marietta Corp., Denver). Astronaut. Aeronaut.; 10: No. 2, 42-51(Feb 1972).

The bases for a proposed system of large nuclear power plants in the oceans producing electric power and hydrogen are presented. The hydrogen would fuel inland power plants and mobile power sources and satisfy most other energy demands. (J.R.D.)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 19320 and 19554.

17774 (CEA-CONF-1792) APPARATUS FOR NEUTRON MEASUREMENT BY LARGE DYNAMIC PULSE FLUCTUATION. Plaige, Y. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 2 Mar 1971. 12p. (In French). (CONF-710340-2). Dep. NTIS (U. S. Sales Only).

From IAEA working group on operation and instrumentation of nuclear power plants; Vienna, Austria (15 Mar 1971).

Pulse instrumentation is largely used for reactor control. Fluctuation instrumentation is being industrially developed and will be used in the near future. These two types of instrumentation operate with the same detector: fission chambers. An instrumentation with large dynamics, using these two basic techniques, was studied. The theoretical analysis of the problem is given. The preliminary results of a practical realization are reported, and the in-pile tests are summarized. From these data it appears possible to develop control instrumentation capable of functioning on a dynamic of 10 decades. (tr-auth)

17775 (CEA-CONF-1793) SAFETY REACTIMETER. Plaige, Y. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 2 Mar 1971. 8p. (In French). (CONF-710340-3). Dep. NTIS (U. S. Sales Only).

From IAEA working group on operation and instrumentation of nuclear power plants; Vienna, Austria (15 Mar 1971).

Reactimeters are very sensitive and very fast instruments. It is for this reason that it is proposed to use them for the safety of reactors, particularly fast reactors in order to detect coolant incidents before the thermal effects have time to be manifested. Because of some simplifications and technological advances, it is possible to construct a simple, sure, and economical instrument. The principle and characteristics of such safety reactimeters are given. The device was tested on a reactor and the results were very satisfactory. (tr-auth)

17776 (DP-1287) COMPUTER-CONTROLLED IN-LINE MONITORING SYSTEM FOR A RADIONUCLIDES SEPARATION PROCESS. Byrd, J. S.; Goosey, M. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec 1971. Contract AT(07-2)-1. 18p. Dep. NTIS.

A dedicated PDP-9 computer was adapted for rapid data acquisition and computation from an in-line Ge(Li) gamma spectroscopy system used to monitor a pressurized ion exchange process for separating and purifying transplutonium elements. Digital discriminating hardware selects for storage only significant portions of a 4096-channel gamma spectrum. Data storage is controlled by the hardware with the direct-access-to-memory feature of the computer. Data acquisition rates are limited only by the processing time of the analog-to-digital converter. Efficient use of hardware significantly simplifies input/output software. Integrated circuit logic modules reduced the cost of the system. (auth)

17777 (LBL-502) HIGH-PURITY GERMANIUM: DETECTOR FABRICATION AND PERFORMANCE. Pehl, Richard H.; Cordi, Richard C.; Goulding, Fred S. (California Univ., Berkeley. Lawrence Berkeley Lab.). Nov 1971. Contract W-7405-eng-48. 17p. (CONF-711111-30). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

The availability of germanium with less than 10^{10} acceptors/cm^3 has enabled the fabrication and study of the performance of germanium detectors of substantially larger volume than has hitherto been possible except by using lithium-drifting techniques. Detectors having a sensitive volume of up to 25 cm^3 have been made. These detectors have a lithium diffused n^+ contact and a metal barrier non-injecting back contact, and are totally depleted. The energy resolution of these detectors is similar to that of equivalent sized lithium-drifted detectors, but the high-purity detectors are easier to fabricate, and present considerably fewer handling problems. (auth)

17778 (ORNL-332(4th Ed.)) HEALTH PHYSICS INSTRUMENT MANUAL. Davis, D. M.; Gupton, E. D. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 65p. Dep. NTIS.

The characteristics and applications of various radiation detection and measuring instruments used for health physics monitoring at ORNL are listed. The instruments are classified as portable, stationary, personnel monitoring, sample counters, and miscellaneous instruments. Also discussed are ORNL gamma sources, beta sources, alpha sources, neutron sources, special sources, special calibration device for monitoring film, calibration device for ionization chambers, alpha calibration source, and calibration of thermal neutron survey meters. (W.H.K.)

17779 (UCRL-51107) REACTION HISTORY NOTES. Gathers, G. Roger (California Univ., Livermore. Lawrence Livermore Lab.). 3 Aug 1971. Contract W-7405-eng-48. 116p. Dep. NTIS.

The unclassified portions of the technology associated with high-speed diagnostic systems using traveling wave tube oscilloscopes are discussed. A discussion of linear systems analysis for exponential signals, oscilloscope displays, system timing, and a derivation of commonly used results is given, and an extensive data collection is presented in the appendices. (auth)

17780 RADIOACTIVITY MEASUREMENT INCORPORATING SAMPLE VAPORIZATION AND ELECTRIC CHARGE COLLECTION. Robinson, Alfred D. (to Cary Instruments). U. S. Patent 3,489,903. 13 Jan 1970. Filed 3 Jan 1966.

An apparatus and method for rapid measurement of radioactivity in a liquid sample are described. The sample is vaporized in an ionization chamber and the resulting electric charge is measured. The method may be used for tritium determination in urine. (W.A.K.)

17781 DISTURBANCE SUPPRESSING RADIATION DETECTOR. Hick, Harald Peter (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). U. S. Patent 3,489,902. 13 Jan 1970. Priority date 10 Dec 1965, Austria.

A disturbance suppressing radiation detector is described. The detector comprises a housing and a collimator therein and a first detector positioned within the housing for receiving primary radiation through the collimator. At least one second detector is disposed within the housing in the range of the secondary scattered radiation from the first detector, and at least one radiation shield is disposed within the housing extending substantially from the interior walls of the housing at a position intermediate to the first detector and the second detector up to but short of a straight line path of the secondary scattered radiation between the first and second detectors. (auth)

17782 FAST-RESPONSE IONIZATION CHAMBER FOR DETECTING IONIZING RADIATION FROM 0.1 TO 60 ANGSTROMS. Taylor, Randolph G.; Lewis, John Jr. (to Secretary of the Navy). U. S. Patent 3,609,435. 28 Sep 1971. Filed 30 Oct 1968.

An ionization chamber having a rectangular housing including therein spaced anode plates with a centrally located cathode is described. The ionization chamber has a fast response for detection of ionizing radiation in various bands from 0.1 to 60 A depending on the gas filling and window material (for example 0.5 to 3.0 A uses a 50-mil-thick beryllium window and 2 atm. of krypton) with a fast recovery. Fast response is brought about by the relationship of the cathode to the anodes in which the spacing and electric field is uniform along the length of and on opposite sides of the cathode. The chamber is filled with a gaseous filling selected from one of the following: nitrogen, carbon tetrachloride, xenon, nitrogen, krypton or argon. It is provided with a removable beryllium, Mylar or aluminum window through which the ionizing radiation enters the chamber. (auth)

17783 MECHANISM FOR POSITIONING A RADIOACTIVE SOURCE IN A LIQUID SCINTILLATION COUNTER. Jacob, Jean Claude (to Intertechnique SA). U. S. Patent 3,609,371. 28 Sep 1971. Filed 11 Jun 1968.

A mechanism for positioning a standard gamma emitter for use as an external standard in a liquid scintillation spectrometer was adapted to move the emitter between a shielded position in a metal body and an operative position close to a sample to be standardized. The mechanism comprises a rotatable disk, an arm carrying the emitter and connected to a motor by a driving mechanism which successively moves the emitter radially inward with respect to the disk, along a part circular path along with the disk and radially outward upon energization of the motor. (auth)

17784 APPLICATION OF TRITON X-100 LIQUID SCINTILLANT TO THE ASSAY OF ^{32}P, ^{33}P, OR ^{35}S IN PLANT DIGESTS OR SOIL EXTRACTS. Sadler, J. M.; Bettany, J. R.; Stewart,

J. W. B. (Univ. of Saskatchewan, Saskatoon). Can. J. Soil Sci.; 51: No. 2, 308-9(Jun 1971).

The effect of the concentrations of primary and secondary fluors on the counting efficiency of Triton X-100 liquid scintillant for the isotopes ^{33}P, ^{35}S, and ^{32}P was examined. In all cases the counting efficiency of the toluene-based Triton scintillant was found to be superior to that of the commonly used 1,4-dioxane-based scintillant. The Triton scintillant was also found to be applicable to the assay of dual labelled solutions. It is well suited to soil-plant studies, where very high degrees of quenching and high salt concentrations may occur. (Canada)

17785 MEAN LIFE OF A SCINTILLATION DETECTOR CRYSTAL. Ficken, George W. Jr. (Cleveland State Univ.). Amer. J. Phys.; 40: No. 2, 352(Feb 1972).

A measurement that students can perform on a scintillation detection system that is interesting because of its analog in radioactive decay is described. The exponentially decaying current pulse from the photomultiplier tube of a scintillation detector, when integrated by the RC network leading into the preamplifier, produces a voltage pulse that closely approximates the form of the decay of a radioactive daughter. (W.H.K.)

17786 CRYOSTAT FOR COOLING VACUUM-HOUSED RADIATION DETECTOR. Marsing, Helmut; Weidmann, Gerhard (to Siemens Aktiengesellschaft). U. S. Patent 3,611,746. 12 Oct 1971. Priority date 26 Mar 1968, Germany.

A loosely assembled cryostat of modular construction which comprises a Dewar vessel having a reservoir of liquid gas refrigerant is described. A vacuum chamber is coupled to the Dewar vessel via a refrigerant transfer device and cooled by refrigerant from the reservoir. The vacuum chamber has a refrigerated surface for mounting a radiation detector (particularly a germanium detector) to be cooled and electrical and evacuating couplings for independent evacuation of the vacuum chamber. The Dewar vessel has a nozzle opening into the area of the reservoir and the refrigerant transfer device includes the nozzle, which is in operative proximity with the refrigerated surface of the vacuum chamber. (auth)

17787 METHOD FOR MAKING VISIBLE RADIATION DAMAGE TRACKS IN TRACK REGISTRATION MATERIALS. Crawford, Wayne T.; Humphrey, James S. Jr.; De Sorbo, Warren (to General Electric Co.). U. S. Patent 3,612,871. 12 Oct 1971. Filed 1 Apr 1969.

An improved method for treating a plastic film to make tracks formed in the film visible is described. The film is subjected to irradiation with charged particles, then is exposed to radiation selected from the group consisting of electromagnetic radiation having wavelengths less than about 4,000 angstroms and electrons having energy levels above about 1.5×10^6 electron volts in the presence of oxygen. When treated with a solvent which preferentially attacks the material along the particle tracks, the tracks dissolve away rapidly, leaving substantially cylindrical holes in the film, with little degradation of the body of the film. This preetching treatment results in more rapid etching of the damage tracks, in tracks of more uniform cross section, in smaller initial pore sizes, and in greater thermal stability of the tracks. (auth)

17788 SELECTIVE DETECTOR FOR FISSION NEUTRONS. Omohundro, Robert J.; Marchetti, Frank A. (to Secretary of the Navy). U. S. Patent 3,612,872. 12 Oct 1971. Filed 26 May 1969.

Fissionable neutron sources are distinguished from nonfissionable sources by utilizing the principle that only a fissionable source emits simultaneously a plurality of neutrons during a single fission event. The simultaneously emitted neutrons are counted in a first coincidence circuit together with random pulses from neutrons emitted by α,n reactions. A second coincidence circuit counts only those neutrons which were emitted separately at spaced intervals of time by α,n reactions and does so by including a delay device in one leg of the coincidence circuit to throw out of coincidence the pulses from the simultaneously emitted neutrons. (auth)

17789 HIGH-TEMPERATURE PROPORTIONAL COUNTER AND INSULATOR CONSTRUCTION THEREFOR. Berry, Daniel S. (to Nuclear-Chicago Corp.). U. S. Patent 3,609,434. 28 Sep 1971. Filed 19 Jul 1967.

A boron nitride core is coated with polytetrafluorethylene (Teflon) or a similar fluorocarbon resin to form a composite gas-sealant insulator for use at temperatures up to about 370°C and highly resistant to mechanical deformation or chemical attack. A flow proportional counter incorporating the insulator construction is employed as a detector in gas chromatography. (auth)

17790 SAMPLE-HANDLING MECHANISM FOR LIQUID SCINTILLATION COUNTING APPARATUS. Hausser, Donald C. (to Nuclear-Chicago Corp.). U. S. Patent 3,610,927. 5 Oct 1971. Filed 11 Apr 1966.

The mechanism of an automatic liquid scintillation counting system employs a cam-driven lever arm to position the elevator to form a vertically compact elevator drive suitable for tabletop use. Precision positioning of samples in the counting position is accomplished at relatively low cost without impairment of reliability by the cam-drive construction which controls the time of operation of the mechanical elements of the system. The light-seal shutter portion of the cam-drive prevents damage due to jamming and jammed samples are detected by abnormality of the camming action thus produced. (auth)

17791 QUENCH COMPENSATION IN LIQUID SCINTILLATION SPECTROMETRY. Thomas, Edward Wherry (to Intertechnique SA). U. S. Patent 3,610,928. 5 Oct 1971. Priority date 19 Jul 1967, France.

For constant efficiency counting of a variably quenched sample labeled with ^{14}C or more energetic isotopes, the counts in two nonadjacent energy ranges, one of which corresponds to the spectrum of the most quenched sample, are added. (auth)

17792 TOMOGRAPHIC RADIATION CAMERA. Walker, William G. (to Nuclear-Chicago Corp.). U. S. Patent 3,612,865. 12 Oct 1971. Filed 8 Nov 1968.

An Anger-type stationary radiation detector having an angular, multichannel collimator rotatably mounted thereon is described. Output circuitry associated with the rotation of the collimator translates the detector output coordinate signals into selected tomographic images of the distribution of radionuclides throughout a stationary object under investigation. (auth)

17793 ELECTRON MULTIPLIER RESPONSE UNDER POSITIVE ION IMPACT. II. SECONDARY ELECTRON PULSE HEIGHT DISTRIBUTIONS. Van Gorkom, M.; Beggs, D. P.; Glick, R. E. (Florida State Univ., Tallahassee). J. Mass. Spectrom. Ion Phys.; 4: No. 6, 441-50(Sep 1970).

Secondary electron pulse height distributions induced by positive noble gas, mono- and diatomic nitrogen and some hydrocarbon ions impinging on a copper-beryllium twenty stage electron multiplier have been determined under standard mass spectrometer operating conditions. Poisson distribution emission functions are observed in all cases for ion impact energies up to 7 keV. Various broadening effects are estimated by measuring the distribution induced at the multiplier by Hg-2652 Å radiation; a deconvolution procedure results in Gaussian distributions, describing electron release at the first dynode. In order to compare the distribution maxima for the various ions studied, it was found necessary to extrapolate the peak maxima to zero count rate. Generally peak maxima are then found to be linear functions of ion kinetic energy in the range 2.8 to 6.8 keV. For the various ions examined, polyatomic ions have higher rates of change of peak maxima per unit ion energy than mono- and diatomic ions. This result parallels the discriminatory behavior found for the integrated electron emission induced under the same operating conditions. Isobaric krypton and cyclohexane ions, for example, can be easily differentiated in plots of peak maxima versus ion energy. Reasons for these differences are discussed and it is tentatively proposed, in the energy range examined, that polyatomic ions neither extensively decompose nor penetrate the metal lattice on impact. Surface rather than bulk and surface effects, as expected for atomic ions, could account for the indicated difference in electron production characteristics. (auth)

17794 RADIATION SURVEY METER WITH DOSE RATE AND DOSIMETER READOUT. Nirschi, Joseph C. (to Secretary of the Army). U. S. Patent 3,614,444. 19 Oct 1971. Filed 21 Nov 1968.

A radiation survey meter adapted to read either dose rate or dose and including a suitable operational amplifier connected to a radiation detector such as an ionization chamber and having a current meter in the output of said operational amplifier is described. The operational amplifier can be connected as an integrator when the current meter is to indicate dose. Alternatively, it can be connected as a current amplifier to indicate dose rate. (auth)

17795 ERROR CORRECTION IN RADIOACTIVE SAMPLE MEASUREMENTS. Laney, Barton H. (to Nuclear-Chicago Corp.). U. S. Patent 3,609,362. 28 Sep 1971. Filed 8 Feb 1968.

A liquid scintillation counting system is described with provision for measuring the efficiency correction of each primary

sample measurement without intervening change of transducer gain. The system is also provided with frequent standardization of transducer gain to eliminate efficiency change due to gain change from both the primary measurement and the efficiency correction measurement. Gain measurement and correction are made by circuits comparing the cumulative differential count on opposite sides of a standard alpha-particle spectrum peak with limit values numerically increased in successively longer portions of the counting interval. Gain correction is made in accordance with statistically probable gain error, and the counting interval is reinitiated. Particular circuits are described. (auth)

17796 DETECTION OF H^+, H_2^+, AND H_3^+ WITH SILICON BARRIER DETECTORS OPERATING IN THE DC MODE. Ray, J. A.; Dandl, R. A.; Barnett, C. F. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 98: No. 2, 211-13(1972).

Silicon barrier detectors have been used to detect H^+, H_2^+, and H_3^+ by using the detector as a dc current amplifier. Measurements were made in the energy range 2 to 35 keV. The gain of the detector was a linear function of energy for H^+ energies in excess of 3 keV. The value of ϵ (energy per electron-hole pair) for incident protons was 4.26 eV obtained with zero voltage across the silicon crystal. (auth)

17797 NEUTRON DETECTING DEVICE. Allemand, R.; Roudaut, E.; Jacobe, J. (to Commissariat a l'Energie Atomique). Canadian Patent 879,390. 24 Aug 1971. Priority date 18 Apr 1968, France.

The device has, in a single enclosure of constant thickness containing a gas, a number $N \times n$ of detector cells disposed at regular intervals, and each consisting of two electrodes. Means are provided for taking off and amplifying two electrical pulses at two different electrodes in each of the cells. One is addressed to one of the n lines and the other to an N column of a matrix-type network comprising $N \times n$ counters each associated by a line and a column of the network with only one of the cells. There are means for applying a potential difference between the electrodes such that each cell operates as an ionization chamber of the disintegration type acting by direct collection of the charges. (Canada)

17798 IMPROVEMENTS IN AND RELATING TO SEMICONDUCTOR RADIATION-DETECTORS. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,253,873. 17 Nov 1971. Priority date 19 Feb 1968, France.

A semiconductor detector with a large sensitive volume for detection and measurement of ionizing radiation is described. The detector comprises a plurality of semiconductor detection elements whose semiconductor crystals have the shape of a prism having an isosceles trapezoidal base and at least one semiconductor junction extending approximately parallel to the two parallel side faces of the crystal. The detection elements are arranged in a regular polygon so that the smaller of the parallel side faces of each crystal is oriented toward the center of the polygon. (W.D.K.)

17799 IMPROVEMENTS IN AND RELATING TO FISSION CHAMBERS. Guery, Marcel (to Commissariat a l'Energie Atomique). British Patent 1,256,450. 8 Dec 1971. Priority date 3 Feb 1969, France.

A pulse type fission chamber comprising a casing which serves as the cathode, an anode within the casing, electric wiring connected to the anode, and a hermetic seal between the casing and the wiring is described. The anode is made of titanium and the sealing means comprises an alumina insulator and is welded using a silver–copper eutectic to the casing and the wiring. (W.H.K.)

17800 RADIATION-DETECTOR CRYOSTATS. (to Siemens Aktiengesellschaft). British Patent 1,255,271. 1 Dec 1971. Priority date 26 Mar 1968, Germany.

A cryostat for a radiation detector, particularly a Ge(Li) detector, is described. (W.H.K.)

17801 PRACTICAL MEASURING TECHNIQUES FOR β RADIATION. Venverloo, L. A. J. London; Macmillan (1971). 162p. £ 3.85.

Topics include ionizing radiation (atoms, stable and unstable nuclei, the equivalence of matter and energy, the laws of radioactive decay, radioactive mixtures, the unit of activity, specific activity, natural and artificial activity); types of radiation and their properties (beta radiation, properties of beta radiation, alpha radiation, gamma radiation, decay schemes, other types of ionizing radiation); radiation detectors (gas-filled detectors, the scintillation detector, semiconductor detectors); radiation measuring equipment (pulse-handling equipment, the detector supply voltage, amplification and pulse shaping, analyzing section, pulse-height discrimination, coincidence and anti-coincidence, counters, time measurements, count-rate meters); measurement and measurement errors (absolute measurements, comparative measurements, measurement errors, the detection limit, choice of the optimum detector and measuring method); the measurement of solid and liquid samples with end-window detectors (absorption, back-scattering in the sample planchet, choice of the detector, measurements on mixtures, high or low activity; high or low energy, preparation of the sample, calibration of the detector, radiochromatography, advantages and disadvantages of measurements on solid samples); measurement with liquid scintillators (detectors with liquid scintillators, solvents and scintillators, quenching, the composition of the scintillator, choice of the window setting, measurements on isotopes other than ^3H and ^{14}C, calibration methods, liquid chromatography); and measurements on gaseous samples (proportional detectors, the efficiency, counting characteristics, adjusting the measuring equipment before use, the counting gas, comparison of the internal gas-filled detector and liquid scintillators, radio gas-chromatography). (UK)

17802 INTERNAL GAS PROPORTIONAL COUNTER FOR MEASURING LOW LEVEL ENVIRONMENTAL RADIONUCLIDES. Schell, W. R. (Teledyne Isotopes, Palo Alto, Calif.). Advan. Chem. Ser.; No. 93, 173-201(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

A membrane proportional counter has been constructed and tested for analyzing radioactive gases at low backgrounds and high pressures. The detector design is similar to the Oeschger type detector but differs in its ability to count all the sample gas. A simple pressure controller permits both sides of the sealed membrane to be filled at the same time with sample and background gas. Wall effects using 3.5 and 7.7 mg/cm^2 between chambers have been measured. Carbon-14, tritium, and argon-37 have been counted at pressures from 1 to 10 atm, at environmental levels. Proportional spectra of background tritium, argon-37, and krypton-83m are presented. Background reduction by 36% was achieved using 2 inch × 4 inch paraffin blocks and cadmium sheet around the detector. The minimum detectable limit for tritium using a 2σ standard deviation of background and a 1000-minute counting time at 800 cm. Hg pressure is ±2 TU. The limit of counting sensitivity for carbon-14 dating is equivalent to a sample age greater than 60,000 years. (auth)

17803 X-RAY AND $\beta-\gamma$ COINCIDENCE SPECTROMETRY APPLIED TO RADIOCHEMICAL ANALYSIS OF ENVIRONMENTAL SAMPLES. Brauer, Fred P.; Kaye, James H.; Connally, Robert E. (Battelle Memorial Inst., Richland, Wash.). Advan. Chem. Ser.; No. 93, 231-53(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

Various $\beta-\gamma$ and x-ray-γ coincidence spectrometers have been used for low level γ spectrometry measurements. The sample to be analyzed is counted simultaneously with a gas flow proportional counter or plastic scintillator and a NaI(Tl) detector. By requiring a coincidence between the detectors the background γ spectrum counting rate can be reduced by more than a factor of 1000. This allows γ spectra to be obtained on samples containing less than 1 d/m of γ activity. A high degree of discrimination is provided against nuclides which do not meet the coincidence requirement. Detector arrangements and sensitivities are discussed for the measurement of ^{131}I, ^{125}I, ^{134}Cs, $^{106}Ru-^{106}Rh$, ^{54}Mn, ^{60}Co, and other nuclides present in environmental samples. (auth)

17804 ACCUMULATION OF FREE CARRIERS IN INSULATED SILICON CRYSTALS. Kovtonyuk, N. F.; Magomedov, A. A.; Bogomolov, P. A.; Kupchinskii, O. I. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 1029-32(Dec 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1174-8(Jun 1971).

An experimental investigation was made of the possibility of fabrication of radiation detectors on the basis of metal/dielectric/semiconductor/dielectric/metal structures made of silicon of $\sim 10^5 \Omega \cdot$cm resistivity. These structures could operate under various conditions: they were capable of fast response under pulsed conditions and of storage in recording of small signals; they also exhibited memory effects. Under pulsed conditions, the polarization current was recorded and the structures had a response time of $\sim 10^{-9}$ sec. The response time was limited by the drift time of carriers across the semiconductor layer. Under storage conditions, the structures had a sensitivity of 10^{-13} W/cm^2. This could be achieved at temperatures sufficiently low to eliminate the influence of thermal generation of carriers which acted as a stray effect. The charge accumulated during illumina-

tion was stored as long as a static bias was applied. The operation of these structures as memory elements was also investigated. (auth)

17805 CHARGE LOSSES IN COUNTERS OF STRONGLY IONIZING RADIATIONS. Afanas'ev, V. F.; Strokan, N. B.; Tisnek, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 4, 699-701(Oct 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 4, 789-92(Apr 1971).

Surface-barrier counters prepared from Si crystals of different resistivities and lifetimes have approximately the same average charge losses $\lambda \sim 0.9\%$. It is shown that radiative recombination cannot explain this constancy. The presence of SiC and SiO_2 inclusions is pointed out, and their inactive-phase behavior as the impurity sinks is studied. The problem of uncorrelated R_ρ and R_τ (inhomogeneities of distribution of resistivity and carrier lifetime over counter cross section) may be resolved by considering separately the distribution of the principal shallow dopant and of the accidental deep recombination centers. (D.L.C.)

17806 USE OF SOLID-STATE TRACK DETECTORS IN NUCLEAR REACTIONS STUDIES. Zoran, V.; Popescu, Gh. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 9, 1127-30(1971). (In Rumanian).

The detection of α particles using cellulose acetate solid state track detectors was investigated. The application of this detection method for measuring angular distributions of α-particle groups from nuclear reactions was checked for the reaction $^{27}Al(p,\alpha)^{24}Mg$ at $E_p = 7.40$ MeV. The agreement of the angular distributions measured by using plastic detectors with those obtained by semiconductor detectors is good. (auth)

17807 STATISTISCHE AUSWERTUNG VON KERNSTRAHLUNGSMESSUNGEN. (Statistical Evaluation of Nuclear Radiation Measurements). Weise, Lothar. Muenchen; R. Oldenbourg Verlag (1971). 160p. DM 40,-.

With respect to radioisotope decay, probability distributions are discussed. The statistical errors are then outlined for digital and analogue measurements. The losses at higher count rates are discussed. Limitations of scintillation counters as detectors are described. The maximum likelihood method is emphasized and compared with the least square method. Significant tests for nuclear decay rates are then discussed, especially according to concepts of Neyman and Pearson. A special chapter is devoted to the χ^2 test. Finally, optimal conditions for statistical evaluation of counting experiments are elaborated. (H.B.G.)

17808 CONCISE DESCRIPTION OF THE WHOLE BODY COUNTER IN LEYDEN AND OF ITS DIAGNOSTIC USE IN ONE CASE. Barnhoorn, A. (J. A. Cohen Instituut voor Radiopathologie en Stralenbescherming, Leiden); van Damme, K. J.; Jansen van Wigmont, J. W. Ned. Tijdschr. Geneesk.; 115: No. 26, 1111-4(26 Jun 1971). (In Dutch).

The i.v. pyelogram of a patient showed strongly contrasting shadows in the areas of liver and spleen. There were good reasons to assume that Thorotrast had been used for a radiological examination to which the patient had been subjected more than 20 years previously. The Whole Body Counter demonstrated the presence of ^{232}Th, thereby confirming this assumption. (auth) (Netherlands)

17809 PROTON ANALYSIS IN THE RANGE 1.5 TO 50 MeV ON ZOND-4 AND ZOND-5. Afanas'eva, N. P.; Kolchin, A. A.; Lebedev, V. V.; Skrebtsov, G. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1202-5(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1531-5(Jul 1971).

Two semiconductor detector systems used on AMS Zond-4 and Zond-5 for cosmic particle detection are described. The first one is a "sandwich" with a geometrical factor of 3.9 $cm^2 \cdot$ ster and is intended for protons in the range of 1.5–10 and 10–21 MeV. The second instrument is a "telescope" that consists of two identical detectors with a geometrical factor of approximately 1.2 $cm^2 \cdot$ ster. Characteristics of the detectors are presented and methods of calibrating the detectors are described. (auth)

17810 DISENO Y CONSTRUCCION DE UN DETECTOR DE SEMICONDUCCION PARA NEUTRONES. (Design and Construction of a Neutron Semiconductor Detector). Lugo, Rafael Martinez. Mexico City; Universidad Nacional Autonoma de Mexico (1971). 63p.

Thesis.

Semiconductor detectors, designed on the principle of the detection of protons scattered elastically by fast neutrons, are studied. The different types of nuclear reactions produced by neutrons, including elastic scattering, are first considered. Some types of detectors used for the detection of neutrons such as the diffraction and time-of-flight methods of detection are discussed. The semiconductor detector used in the present study and its properties and characteristics and the characteristics of the hydrogenated material used as proton converters are described. The experimental method and the results are discussed. (J.S.R.)

17811 DISENO Y CONSTRUCCION DE UN SISTEMA PORTATIL PARA DETECTAR RADON. (Design and Construction of a Portable System for Radon Detection). Bautista, Armando Chavez. Mexico City; Universidad Nacional Autonoma de Mexico (1971). 98p.

Thesis.

The design and construction of a portable radon detector is described. The system consists of the detector, the amplification and counting system, and the mechanical part. A surface barrier semiconductor detector is used for the detection of the radon decay products because of its simplicity and its special characteristics. The electronic part of the system consists of both linear and non-linear circuits. The linear circuit has the function of amplifying the input signal and it must have the characteristics of high impedance, low input capacity, and low noise. In order to obtain these characteristics a field effect transistor is used. The non-linear circuit has the function of forming pulses adequate to satisfy the characteristics of the counter for counting by means of a rate meter. The mechanical part consists principally of an aspirator whose aperture is covered by a filter to trap the dust particles containing the radon decay products. (J.S.R.)

17812 DETECTORES NUCLEARES DE SEMICONDUCCION SENSIBLES A LA POSICION. (Position-Sensitive Semiconductor Detectors). Mansilla, Hector Ocampo. Mexico City; Universidad Nacional Autonoma de Mexico (1971). 76p.

Thesis.

The design and fabrication of position-sensitive semiconductor detectors are described. Experimental studies on the efficiency of these detectors showed that both the detector of continuous sensitivity and the zone sensitive detector can determine the incidence position of radioactive particles with sufficient accuracy. (J.S.R.)

17813 OPTIMIZATION OF FOCUSING COLLIMATORS WITH SEGMENTAL CHANNEL CROSS SECTION. Abraham, K. (Medizinische Akademie, Magdeburg, Ger.). Isotopenpraxis; 7: No. 9, 369-73(Sep 1971). (In German).

Compared with scintigraphic collimators having circular or honeycomb channel cross section, focusing collimators with the same parameters R, f, D, and P_s provide a higher counting rate without loss of resolution. The performed calculation shows that segmental collimators are optimal when the number 2i of channels in the first ring is six. (auth)

17814 FERROELECTRIC FIELD EFFECT RADIATION DETECTOR STUDIES UTILIZING OXYGEN DEPLETED LEAD ZIRCONATE TITANATE SURFACE LAYERS. Miller, Don Wilson. Columbus, Ohio; Ohio State Univ. (1971). 255p. University Microfilms Order No. 71-27,522.

Thesis.

Analyses of the conceptual design and application of the ferroelectric field effect in the development of a device for the detection of radiant energy demonstrate that this device may have superior sensitivity and characteristics for particular applications such as radiographic imaging. The ferroelectric field effect radiation detector (FFERD) is a ferroelectric detector and an insulated gate field effect transistor integrated into a single device. In the operation of this device the conductivity of a semiconductor layer is dependent upon the polarization state of a ferroelectric substrate, the polarization state being dependent on the radiant energy absorption. Theoretical calculations predict voltage gains of 10^5 at a frequency of 30 Hz. In the technological development of the device, semiconductor layers were grown via the oxygen depletion of ceramic $Pb(Zr_{.65},Ti_{.35})O_3 + 1$ wt % Nb_2O_5 (PZT), which heretofore was an unknown semiconductor with unknown properties. The properties of oxygen depleted PZT surface layers were studied using the Hall effect, $\log(\sigma) = f(1/T)$ measurements, and frequency dependent dielectric measurements. Measurements of the polarization coupling to the semiconductor layer conductivity indicate negligible coupling coefficients. This result can be explained using the semiconductor model and the measured data, and is attributed to the partially ionized characteristic of the oxygen depleted semiconductor layer. These data along with the model predict that 92 percent of the field effect

coupling occurs with the semiconductor ionization state rather than the mobile charge carriers. As a consequence, the field effect coupling ionizes the semiconductor layer rather than modulating the conductivity. This result precludes the application of an oxygen depleted PZT surface layer to a ferroelectric field effect device. However, as a consequence of this study the concept of the FFERD has been developed and the required semiconductor layer properties have been identified. These properties include the lattice structure, the carrier concentration, the ionization state of the dopant, the dielectric constant, the carrier mobility, the semiconductor type, and the thickness of the semiconductor layer. (TSS) (Diss. Abstr. Int., B)

17815 INFLUENCE OF VIALS MADE OF DIFFERENT MATERIAL AND OF SCINTILLATOR ON THE CONSTANCY OF THE EXTERNAL STANDARD CHANNEL RATIO IN LIQUID SCINTILLATION COUNTING. Rauschenbach, P.; Simon, H. (Technische Univ., Munich). Z. Anal. Chem.; 256: No. 2, 119-23(1971). (In German).

Using toluene scintillators in vials of polyethylene and ^{133}Ba or ^{137}Cs as a nuclide for external standardization, the external standard channel ratio decreases after many hours. The cpm values of tritium labeled samples and the sample channel ratio are constant all the time. An external standard of $^{226}Ra/^{241}Am$ does not show any change in the external standard channel ratio. Vials made of glass, nylon, and polyethylene show different standard deviations of the external standard channel ratio. (auth)

17816 MEASURING EQUIPMENT FOR NUCLEAR MEDICINE. Broj, Karel; Dvorak, Viktor; Vesely, Vladimir (Research Inst. of Nuclear Equipment Construction, Premysleni, Czech.). Jad. Energ.; 17: No. 10, 336-42(Oct 1971). (In Czech).

An assembly of devices for nuclear medical research enabling one to perform both in vivo measurements (^{131}I accumulation in the thyroid gland and kidney activity in adults and children), and in vitro (experimental volumes, say up to 1.5 l) using gamma isotopes is described. Such an assembly is made up of separate modules designed for this type of application. Mechanical and electrical specifications are given for spectrometers, detectors, and associated equipment. (tr-auth).

17817 PLASTIC SCINTILLATING FOIL. Novakova, Olga; Nejedla, Blanka (Research Inst. of Nuclear Equipment Construction, Premysleni, Czech.). Jad. Energ.; 17: No. 10, 333-6 (Oct 1971). (In Czech).

The preparation of soft plastic scintillation foils is described. These are characterized by considerable durability and mechanical stability. A method for evaluating such foils is suggested. (tr-auth).

17818 PARAMETERS OF SLOW NEUTRON CORONA COUNTERS OF THE TYPE KNN 201. Gilar, Oldrich; Pavlicek, Zdenek; Zampa, Antonin (Research Inst. of Nuclear Equipment Construction, Premysleni, Czech.). Jad. Energ.; 17: No. 10, 326-9(Oct 1971). (In Czech).

The results are presented for the measurement of parameters of corona counters for slow neutrons, type KNN 201 with boron-covered cathodes, as developed by the Research Institute of Nuclear Equipment Construction, Premysleni. (tr-auth)

17819 METHOD FOR THE MEASUREMENT OF FLUORESCENCE LIFETIMES IN THE NANOSECOND REGION USING A SAMPLING OSCILLOSCOPE. Onishi, Masayoshi; Niki, Eiji (Tokyo Univ.). Jap. Anal.; 20: No. 11, 1428-34(Nov 1971). (In Japanese).

A photomultiplier, pulse amplifier, and sampling oscilloscope are used to measure the lifetimes of activated fluorescent molecules in the nanosecond region. The circuits are given; and results are given for Cherenkov radiation produced in quartz by ^{90}Sr beta particles, scintillation pulses produced in a liquid scintillator by ^{14}C beta particles, and scintillation pulses produced in NaI(Tl) by ^{137}Cs gamma rays. (W.H.K)

17820 COMPARATIVE SENSITIVITY OF NUCLEAR PHOTOGRAPHIC EMULSIONS USED IN AUTORADIOGRAPHY. Merkulov, M. F.; Kortukov, E. V. (Kuban State Medical Inst., Krasnodar, USSR). Zh. Nauch. Prikl. Fotogr. Kinematogr.; 16: No. 5, 326-35(Sep-Oct 1971). (In Russian).

An evaluation of native and foreign photographic emulsions is offered based upon a variety of literature sources. Topics of discussion include crystal size of the silver halide and energy dependence of emulsion sensitivity to electrons. The emulsions are grouped according to the isotope selected for autoradiography. 48 references. (K.S.W.)

17821 MEAN IONIZATION ENERGY IN Ar–CH_4–Kr AND Ar–CH_4–H_2 MIXTURES. Carlier, J. (Institut du Radium, Paris). Rev. Phys. Appl.; 6: No. 3, 297-300(Sep 1971). (In French).

Measurements of the mean ionization energy, W, of α particles were carried out with pure Ar and Kr contained in the binary mixtures: Ar–CH_4, Ar–Kr, Kr–CH_4, and Ar–H_2, and in the ternary mixtures Ar–CH_4–H_2, and Ar–CH_4–Kr. The law establishing the variations in W for binary mixtures is satisfactorily obeyed in the case of Ar–H_2. In the same concentration range the same law can be applied to the Ar–CH_4–H_2 mixture if the Ar–CH_4 mixture is considered as a single component. The results obtained with Ar–Kr and Ar–CH_4–Kr mixtures demonstrate that the Kr and CH_4 behave differently, depending upon the various excited states of the Ar atom. This observation led to the proposal of a series of reactions, explaining the experimental data, in particular for the Ar–Kr mixture. (France)

17822 CHARGED PARTICLE ACCELERATOR WITH SINGLE OR MULTIMODE OPERATION. Greber, Henry U. S. Patent 3,617,908. 2 Nov 1971. Filed 24 Feb 1969.

A particle accelerator which can be made in linear, circular, helical or spiral form is described. It functions in one, or in a combination of modes of operation as a double betatron, double cyclotron, double traveling wave tube, or double-rotating magnetic flux device. In the double betatron mode, the particles rotate around two magnetic fluxes intertwined like two consecutive links of a chain. In the double cyclotron arrangement, the particles are accelerated at their passage between two consecutive tubes, and also between two halves of the same tube section, split longitudinally. In the traveling wave tube mode, the particles are accelerated through their energy exchange with traveling waves flowing along a coiled helical winding. In the arrangement with two sets of windings producing two interlinked rotating magnetic fluxes, the particles act like free electrons in the rotor of an asynchronous motor. In any one, or in any combination of these modes of operation of this particle accelerator, the particles perform a motion along a helical path, along which they cut the lines of the magnetic force of a radial, stationary, (DC excited) magnetic flux, which induces in them an electromotive force in the direction of their acceleration. Normally, this particle accelerator is evacuated, but it can also be filled with a semiconductor, semimetal, or electrolyte, with the result of a considerable simplification of the device. This accelerator can be used for single, or for repeated passages of the particles through it. (auth)

17823 MEASURING DEVICE FOR DETERMINING LIFETIMES OF EXCITED NUCLEAR STATES. Krueger, E.; Mihlan, H.; Schuster, H. J. PTB Mitt.; 81: No. 5, 319-22(Oct 1971). (In German).

For lifetime measurements in the range of 1 μs up to 1 s by delayed coincidences it is desirable to determine all time differences up to a maximum value $T > \tau$ between the nuclear particles or photons populating the state of lifetime τ and the ones deexciting this state. For that purpose the times at which the nuclear particles arrive at the detector are measured by a special digital electronic clock, and the time differences of interest are calculated on-line and stored by a computer. The measuring device allows to handle up to 3000 particles per second by high speed circuitry and fast machine code programming. The gain in statistical accuracy reached by this method relative to the conventional method is demonstrated by an experimental example. (auth)

17824 ABSOLUTE EFFICIENCY OF ORGANIC SCINTILLATORS IN SOLUTION. Guesten, H.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys. Chem. (Frankfurt); 75: No. 3-4, 113-17(Aug 1971). (In German).

The system scintillator–photochemical active compound offers an experimentally simple way for the determination of absolute scintillation efficiency of organic scintillators in solution. The absolute scintillation efficiencies of the common organic scintillators (p-terphenyl, 2,5-diphenyloxazole (PPO), 2-phenyl-5-(4-biphenylyl)-1,3,4-oxadiazole (PBD) and 1,4-Bis-(2-(5-phenyloxazolyl)benzene (POPOP) in toluene under oxygen free conditions range between 1.5 and 2.5%. (auth)

17825 INTERPRETATION OF ERRORS IN COUNTING EXPERIMENTS. Currie, Lloyd A. (Univ., Bern. National Bureau of Standards, Washington, D. C.). Anal. Lett.; 4: No. 11, 777-84(1971).

Digital experiments, such as the measurement of radioactivity, are usually governed by the binomial or Poisson distribution. Three types of difficulty which commonly arise in the statistical treatment of such experiments include: (a) failure to recognize that the physical quantity of interest may be governed by a compound probability distribution, particularly, when dealing with short-lived radioactivity; (b) the improper use of the chi-squared statistic when making standard error estimates in least-squares

calculations; and (c) selecting the correct number of degrees of freedom and choosing between the χ^2 dispersion test and the goodness-of-fit test for grouped data. Examination of the nature of each of these difficulties is followed by a recommended course of action. (auth)

17826 GAMMA INSENSITIVE AIR MONITOR FOR RADIOACTIVE GASES. Jalbert, Roland A.; Hiebert, Richard D. (to United States Atomic Energy Commission). U. S. Patent 3,621,238. 16 Nov 1971. Filed 10 Sep 1970.

An ionization chamber instrument for measuring the concentration of radioactive gases in air is described. External gamma radiation effects on the instrument are eliminated through use of a compensating chamber mounted next to the measuring chamber with both chambers orbiting about a common axis. (auth)

17827 INDUCED-NOISE DISCRIMINATING CIRCUIT. Kumahara, Tadashi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Tech. (Tokyo); 8: No. 11, 644-8(Nov 1971).

An improved discriminating circuit which can eliminate noise counts induced in nuclear radiation counting systems by various control devices such as motor controllers has been developed. A description is given of the principle, circuits, and some experimental results. The circuit is basically composed of an ordinary threshold discriminator, an undershoot detecting circuit, a temporary memory, and a delay pulse generator. The temporary memory is triggered by the output pulse of the threshold discriminator and reset by the output pulse of the undershoot detecting circuit or the output pulse of the delay pulse generator. This discriminating circuit generates an output pulse when the undershoot detecting circuit does not emit its output pulse within a predetermined time from the leading-edge of the threshold discriminator output pulse. The experimental results show that this discriminating circuit can reject 97% of the noise counts in a nuclear radiation counting system, compared with the corresponding data obtained with a conventional discriminator with the pulse-height discrimination alone. (auth)

17828 DOUBLE-CRYSTAL SOFT X-RAY SPECTROMETER. Suoninen, E.; Karras, M.; Levoska, J. (Univ., Oulu, Finland. Univ., Turku, Finland). Acta Polytech. Scand., Phys. Nucl. Ser.; No. 71, 1-20(1970).

The effect of the choice of various design parameters and the alignment of the instrument upon the resolution of an x-ray spectrograph in the region $\lambda \approx 5$ to 10 Å is discussed. The influence of the mosaicness of the analyzing crystals upon the resolution and the intensity is treated in detail. The relative advantage of perfect crystals at high Bragg angles is emphasized. The construction of an instrument using two highly perfect calcite crystals (reflection face 211) is described. The operation of the instrument is tested with measurements of the V/K_α and S/K_β lines at the parallel and antiparallel positions. The results are compared with previous work reported in the literature. (auth) (Finland)

17829 IMPROVEMENTS RELATING TO THE DETECTION OF IONISING NUCLEAR RADIATIONS. Kozlov, Stanislav Fedorovich (to Fizichesky Institut Imeni P.N. Lebedeva). British Patent 1,260,321. 12 Jan 1972. Priority date 27 Sep 1968, Russia.

A type IIa diamond crystal detector is described for detecting ionizing radiation in a gamma background or for measuring the rate of energy loss of ionizing radiation (dE/dx detector). (W.H.K.)

17830 BETA PARTICLE DETECTION IN THIN NUCLEAR DETECTORS. Johnston, Phillip A.; Gelezunas, Vincent L. (to United States Atomic Energy Commission). U. S. Patent 3,621,257. 16 Nov 1971. Filed 9 Mar 1970.

A detector for detecting and measuring the energy of low-energy beta particles is described. The detector consists of a diode semiconductor detector and a foil for backscattering the beta particles into the detector when they pass through the detector the first time. (W.H.K.)

17831 DIFFERENTIAL PRESSURE NUCLEAR RADIATION FLUX DETECTOR. Borkowski, Casimer J. (to United States Atomic Energy Commission). U. S. Patent 3,621,254. 16 Nov 1971. Filed 22 Apr 1970.

A radiation flux detector is described which includes a pair of ionization chambers, each filled with a different gas and each sensitive and nonsensitive, respectively, to the flux being measured, located in the flux of interest. The pressure in the chamber filled with the sensitive gas changes at a faster rate than in the other chamber in the presence of the radiation flux and the differential pressure between the chambers is measured by a remote detector communication with the chambers to provide an indication of the flux density. (auth)

17832 TWO-DIMENSIONAL COINCIDENCE APPARATUS FOR $\gamma\gamma$-ANGULAR CORRELATION MEASUREMENTS AFTER THERMAL NEUTRON CAPTURE. Delang, W.; Goettel, P.; Seyfarth, H. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods; 99: No. 1, 13-17(1972).

A coincidence apparatus for angular correlation measurements on thermal-neutron-capture γ rays is described. The output signals of two Ge(Li) detectors are digitized by two 4K ADC's. The address pairs of coincident events are recorded on magnetic tape. In this way the angular distributions of all γ cascades of the decaying nucleus can be measured in a single run together with the coincidence background. (5 figures) (auth)

17833 MULTI-WIRE PROPORTIONAL COUNTER SYSTEM FOR USE IN LOW, MEDIUM, AND HIGH ENERGY PHYSICS. Buchanan, J.; Coulson, L.; Gabitzsch, N.; (and others) (Rice Univ., Houston, Tex.). Nucl. Instrum. Methods; 99: No. 1, 159-72(1972).

Multiwire proportional counter systems were constructed for applications to low-, medium-, and high-energy nuclear physics problems. Details of the construction of the counters and the associated electronics and computer interface are discussed. The operating characteristics of the system in a 300 MeV/c π^- beam are presented. (19 figures) (auth)

17834 EXPERIMENTAL TOTAL AND PHOTOPEAK EFFICIENCIES OF HARSHAW 7F8 WELL CRYSTAL FOR CYLINDRICAL GAMMA RAY SOURCES. Murty, M. Sriramachandra; Rao, A. Lakshmana; Rama Rao, J. (Andhra Univ., Waltair, India). Nucl. Instrum. Methods; 99: No. 1, 147-50(1972).

Total and photopeak efficiencies of a standard Harshaw 7F8 NaI(Tl) well crystal were determined for cylindrical gamma-ray sources of 1.5 cm diameter and various heights ranging from 0.1 cm to 3.5 cm, over a photon energy range 0.032 to 1.69 MeV. By a process of simulation, the self-absorption effects were taken into account experimentally by using typical absorbing media, Al, Ni, Cd, and Pb. The data are presented in graphical form together with discussion. (9 figures, 1 table) (auth)

Radiation Dosimeters

17835 (ORNL-TM-3551) 1970 INTERCOMPARISON OF NUCLEAR ACCIDENT DOSIMETRY SYSTEMS AT THE OAK RIDGE NATIONAL LABORATORY. Haywood, F. F. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 67p. Dep. NTIS.

The seventh in a series of intercomparison studies of accident monitoring systems was held from July 20–31, 1970. The ORNL Health Physics Research Reactor was used as the fission source. Personnel monitoring badges and detectors used as area monitors were compared. Three different spectra were used to simulate nuclear accidents. Results of the experiment indicated that reported values of dose were within ±22% for all pulses. It should be noted that for the unshielded reactor environment, measurements were within ±5% for neutron dose and within ±9% for gamma dose at one standard deviation. The uncertainty of values for neutron fluence in several energy groups was slightly higher than those for dose. (auth)

17836 (UCRL-50007-71-2) HAZARDS CONTROL PROGRESS REPORT NO. 40, MAY–AUGUST 1971. (California Univ., Livermore. Lawrence Livermore Lab.). 19 Oct 1971. 25p. Dep. NTIS.

Activities underway in the fields of radiation protection, instrumentation development, and environmental protection are covered in the first section; final results will be published later. The second section contains brief reports on the following work: The feasibility of using a gas-evolution dosimeter for measuring high-intensity radiation fields was studied. Under intense irradiation polyethylene film releases hydrogen gas, with the pressure buildup approximately proportional to absorbed dose. Problems associated with handling the dosimeter, however, outweighed its potential usefulness. A background radiation study on TL dosimeters suggested the feasibility of changing TLD's quarterly instead of annually. No appreciable change in the sensitivity of a TL crystal was caused by multiple annealings. Work on the calibration of a tritium stack monitor is summarized. A computer program was written for the calculation of NaI(Tl) detector efficiency for point and disk radiation sources. Apparatus was developed for locating gas-block plugs in signal cables used in underground nuclear blasts. A commercially available ionization-type smoke detector was adapted for use with battery power. One means of preventing release of hazardous materials from buildings is to maintain the buildings at negative pressure. As an aid in designing such systems, an equation expressing the building pressure as a

function of the pressure/time profile in a "maximum credible fire" was derived, and a computer program to compute the pressure/time profile for various exhaust fan removal rates was written. The third part of the report lists recent publications. (18 figures, 4 tables) (R.W.R.)

17837 THERMOLUMINESCENT MATERIAL FOR DOSIMETRY. Carpentier, Serge; Dajlevic, Radovan; Delarue, Roger; (and others) (to Commissariat a l'Energie Atomique). French Patent 1,603,815. 7 Jun 1971. Filed 18 Sep 1968. (In French).

A thermoluminescent material for the dosimetry of ionizing radiations is discussed. It consists of alumina containing between 10 ppm and 1% Na by weight and between 10 ppm and 1% F by weight. The alumina is in the form of grains with dimensions less than 400 μ, more than 80% by weight being in the α crystal phase. (France)

17838 DOSIMETER FOR PULSED IONIZING RADIATION. Halpin, Joseph J.; Wenzel, Richard F. (to Secretary of the Navy). U. S. Patent 3,614,435. 19 Oct 1971. Filed 10 Dec 1968.

The invention is directed to a dosimeter for pulsed beams of high-energy, ionizing radiation. The dosimeter employs the radiative recombination of radiation-induced excitation in a material. The dose is proportional to this fluorescence signal at any time. To be useful, this fluorescence should have a lifetime about an order of magnitude greater than the duration of the radiation pulse, so as to make the excitation to occur instantaneously. In addition, the material should be relatively insensitive to lattice displacement effects so that the dosimeter may be used for large cumulative doses. An example of such a material is low chromium concentration ruby single crystals (Al_2O_3: Cr), i.e., Cr concentrations 0.0003 percent to 0.001 percent by weight. (auth)

17839 POCKET ALARM DOSIMETER. Brodsky, Robert S. U. S. Patent 3,614,442. 19 Oct 1971. Filed 28 Apr 1970.

A portable pocket alarm dosimeter employs an electronic radiation counter where total dosage is accumulated in digital form in a serial counter. An alarm is provided for advance warning at a preset integrated radiation dosage. The integrating device retains 100 percent of the pulses generated by the counter. The alarm levels can be readily changed to correspond to any particular application because of its extreme accuracy and its ease of adjustment. (auth)

17840 DOSIMETER AND METHOD FOR DETERMINING THE LEVEL OF RADIATION FROM AN ELECTRONIC APPARATUS HAVING A PLURALITY OF RADIATION EMITTING SURFACES. Brennan, John F. U. S. Patent 3,612,870. 12 Oct 1971. Filed 3 Sep 1968.

The dosimeter is particularly useful in checking the amount of X-ray radiation from home television receivers to determine whether or not the receivers are safe. The dosimeter comprises a casing which contains a radiation sensitive film packet. A radiation screen is provided in front of the film packet. Means are provided to either move the screen or to move the film to selectively expose different portions of the film. The dosimeter may be used for determining the level of radiation from an electronic apparatus having a plurality of radiation-emitting surfaces. The dosimeter is first placed closely adjacent to one of the radiation-emitting surfaces. A portion of the film is then exposed to radiation from the surface for a predetermined time interval. The dosimeter is then selectively placed adjacent to each of the remaining radiation-emitting surfaces and other portions of the film are exposed to radiation for predetermined time intervals. The film is then developed and the amount of dosage received by each of the exposed portions is measured. The results of this measurement are compared with a standard to determine whether or not the radiation from the apparatus is within safe limits. (auth)

17841 THERMOLUMINESCENCE DOSIMETER DEVICE. Hasegawa, Seiro; Matsushima, Hiroshi (to Matsushita Electric Industrial Co., Ltd.). U. S. Patent 3,614,436. 19 Oct 1971. Priority date 28 Dec 1967, Japan.

A digital electrometer having an electrometer amplifier and a digital voltmeter for giving a digital display of a very low voltage for use in a thermoluminescence reader is described. In the device, an analog to digital converter converts the output from the electrometer amplifier into a digital quantity and the digital output from the analog to digital converter is counted by a counter for the digital display of the voltage. (auth)

17842 IMPROVEMENTS IN RADIATION DOSIMETERS. (to Instytut Badan Jadrowych). British Patent 1,256,268. 8 Dec 1971. Priority date 27 Aug 1968, Poland.

An ionization chamber with tissue-equivalent electrodes and high-pressure filling gas is described for measuring dose equivalents of ionizing radiation having an unknown composition and spectrum. (W.H.K.)

17843 DOSIMETER FOR A BETATRON. Tabarovskii, I. K.; Mandel'tsvais, Yu. B.; Vvedenskii, V. T.; (and others) (to All-Union Research Inst. of Medical Instrument Manufacture). Russian Patent 243,744. 14 May 1969. Filed 17 Apr 1967. (In Russian).

The dosimeter described contains a semiconductor detector, monitoring equipment, and an apparatus for automatic disconnection of the betatron after collection of a determined radiation dose. In order to measure the integral dose with a high degree of precision as well as the intensity of the radiation dose, analog-frequency converters for weak currents with proportioning condensers are inserted, along with graduated diodes in inverted circuits. (K.S.W.)

17844 HIGHSENSITIVE MINIATURE TSEE-DOSIMETER. Boros, Laszlo. Magy. Radiol.; 23: No. 5, 257-62(Oct 1971). (In Hungarian).

The sensitivity of miniature BeO-ceramic TSEE-dosimeters was extended by 2 orders of magnitude to the lowest detection limit of 1 μR. The dosimeters are energy and angular independent, and the dose-response ratio is linear and proportional in the dose range of 5 orders of magnitude. (auth)

17845 LOW-ENERGY DOSIMETER AND METHOD OF MAKING SAME. Jackson, Thomas P. U. S. Patent 3,628,019. 14 Dec 1971. Filed 13 Mar 1969.

The construction of an ionization chamber for dose measurement of low-energy radiation of 30 keV and less is described. (W.H.K.)

17846 COMPORTAMIENTO DE DOSIMETROS TERMOLUMINISCENTES (TLD) FRENTE A DIVERSAS FUENTES DE RADIACION. (Behavior of Thermoluminescent Dosimeters with Different Kinds of Radiation). Nieto, Juan Azorin. Mexico City; Instituto Politecnico Nacional (1971). 82p.
Thesis.

Manganese-activated lithium borate is studied as a thermoluminescent dosimeter. This material was selected because of its low cost and easy preparation. The results of the study of the behavior of Mn-activated lithium borate prepared with natural Li and with ^{6}Li to n, n + γ and γ radiations are reported. The results were compared with the behavior of the commercial LiF dosimeters TLD 100, TLD 600, and TLD 700. The comparison showed that the dosimeters prepared by the CNEN were as efficient as the commercial dosimeters. (tr-auth)

17847 CALORIMETER FOR STANDARD ENERGY DOSE MEASUREMENTS AND DETERMINATION OF THE AVERAGE ENERGY EXPENDED IN AIR TO FORM ONE ION PAIR. Engelke, B. A.; Hohlfeld, K. PTB Mitt.; 81: No. 5, 336-42(Oct 1971). (In German).

A quasi-adiabatic calorimeter designated for standard measurements of the absorbed dose produced in graphite by photons with energies E > 0.5 MeV is described in detail. In the dose range above 0.5J/kg (50 rads) the accuracy is better than 1%. Temperature drift rates can be reduced below 10^{-6} K/min. By calorimetric measurement of the absorbed dose and measurement of the ionization per unit mass of air under the same conditions the average energy W_{air} expended in air to form one ion pair was determined to be W_{air} = (33.72 ± 0.51) eV for gamma radiation of ^{137}Cs. (auth)

17848 SYSTEM FOR MONITORING PERSONNEL THERMOLUMINESCENT DOSIMETERS, AND DOSIMETERS FOR USE WITH SAME. Perry, Kenneth Edward Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,259,836. 12 Jan 1972. Filed 28 Jun 1968.

A personnel dosimeter is described that comprises a charge of thermoluminescent material contained in a separable holder, the latter bearing data indicating the wearer's identity and the period of use. The read-out system employed enables measurements to be made with the container in its holder and includes transfer means for moving the dosimeter to a number of locations at which the data on the holder and the dose stored by the thermoluminescent material are read out and recorded. The system avoids the risk of mistakes in associating the results with a particular wearer. (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 19863.

17849 (ANL-7763) TECHNIQUES AND ANALYSES OF FAST-REACTOR NEUTRON SPECTROSCOPY WITH PROTON-RECOIL

PROPORTIONAL COUNTERS. Bennett, E. F.; Yule, T. J. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 67p. Dep. NTIS.

Techniques and analyses are described for fast-neutron spectroscopy with proton-recoil proportional counters. Small, nonperturbing cylindrical counters filled with hydrogen or methane are used in an isotropic flux environment to measure degraded fission spectra in the energy range from 1 keV to 2 MeV. Electronic pulse-shape discrimination distinguishes between gamma-ray induced events and proton recoils. Correction schemes are employed that remove systematic errors inherent in this method of neutron spectroscopy. Sources of error are the nonlinear relationship between energy and ionization at low energies, wall-and-end distortion at higher energies, and distortion of internal field lines at the ends of the counter. The extent of these corrections is assessed for a representative fast-reactor spectrum. (auth)

17850 (ARMS-69,6,11) AIRBORNE ALPHA SPECTROMETER: SYSTEMS AND PROCEDURES IN SUPPORT OF THE APOLLO PROGRAM. Boyns, P. K.; Anderson, C. N. (EG and G, Inc., Las Vegas, Nev.). Nov 1969. 20p. (EGG-1183-1455). Dep. NTIS.

The use of ^{238}Pu in thermoelectric generators for Apollo missions required the development of a high-sensitivity Pu detector to search for ruptured Pu capsules in event of accident. An alpha spectrometer that can be operated from the ARMS aircraft is described. The spectrometer can detect ^{238}Pu in air below the maximum permissible concentration of 10^{-12} $\mu Ci/cm^3$, without interference from naturally occurring airborne alpha emitters. Also included is information on the aircraft positioning system, air sampling, and the procedures to be followed when actually using the spectrometer. (8 figures, 1 table) (R.W.R.)

17851 (EGG-1183-5000) SPECTRAL UNFOLDING USING STEPWISE REGRESSION OF SYSTEM RESPONSE FUNCTIONS. Beers, Richard H. (EG and G, Inc., Los Alamos, N. Mex.). 16 Apr 1971. Contract AT(29-1)-1183. 31p. Dep. NTIS.

For Los Alamos Scientific Lab., N. Mex.

This report describes a spectral unfolding procedure that generates a unique solution, an envelope of solutions within a given confidence interval, and a statistical goodness-of-fit evaluation. The solution generated is based on a series expansion of the unknown spectrum in terms of the system response functions. Such a solution is shown to be the best possible solution consistent with the observed data. Prior knowledge of characteristics of the spectrum to be determined may be used to modify the solution; however, such modifications, when not based upon direct observation, must be so qualified. An example is presented in which the output spectrum of a laboratory x-ray machine is unfolded from photographic film depth-dose data. (auth)

17852 (LA-4775) SPACE- AND TIME-DEPENDENT SLOWING DOWN IN HEAVY MEDIA. Weisbin, C. R.; Forster, R. A.; Smith, D. B.; Corngold, N. (Los Alamos Scientific Lab., N. Mex.). Jan 1972. Contract W-7405-eng-36. 9p. Dep. NTIS.

To evaluate the potential of the lead slowing-down-time spectrometer quantitatively as a nuclear safeguards assay device, the time-, space-, and energy-dependent neutron diffusion equation was solved for heavy moderators, and a FORTRAN-IV program, SLAHM (Slowing-Down Analysis in Heavy Moderators), was written to perform the required integrations. By using this new calculational tool, spectral and spatial distributions were obtained at a variety of times following introduction of a 14-MeV point source of neutrons into several different-sized lead assemblies. One can apparently achieve a $^{235}U/^{239}Pu$ discrimination ratio ≥ 5 with only limited self-shielding (even for high-enrichment fuels) by examining the energy regions from 2.8 to 3.8 and 56 to 100 eV or, for highly enriched plutonium breeder fuel, 2.8 to 3.8 and 56 to 66 eV. Note that this technique requires a 2-m cube. Further, the neutron population for energies below the inelastic threshold based upon exponential attenuation ($e^{-B^2\tau}$) involving the neutron age (τ cm^2) must be estimated very carefully. The "true" age was shown to be sensitive to both cross-section variation and the "free ride" afforded by the (n,2n) interaction. (4 figures, 3 tables) (auth)

17853 (ORNL-TM-3683) SETUP AND CONTROL ROUTINES FOR A PULSED NEUTRON TIME-OF-FLIGHT SPECTROMETER. Gilley, L. W. (Oak Ridge National Lab., Tenn.). 4 Feb 1972. Contract W-7405-eng-26. 31p. Dep. NTIS.

The programming required for setup and control of an experiment on a magnetically pulsed neutron time-of-flight spectrometer installed at the HFIR is described. After a general description of the hardware and software, some of the routines are discussed in greater detail and some examples of experimental setup are given. (1 figure, 4 tables) (R.W.R.)

17854 FAST NEUTRON SPECTROSCOPY IN AQUEOUS MEDIA USING AN NE-213 PROTON-RECOIL NEUTRON SPECTROMETER SYSTEM. Coolbaugh, Morris Jackson. Manhattan, Kan.; Kansas State Univ. (1971). 156p. University Microfilms Order No. 72-1783.

Thesis.

A fast neutron spectrometry system was constructed for neutron spectra determinations in aqueous media. This system comprises an NE-213 liquid organic scintillator cell, a long light pipe to transmit the scintillation light to a photomultiplier tube, and associated electronics to discriminate against gamma-ray induced pulses. Extensive energy calibration of this system was avoided by developing a derivative method data analysis code which uses experimentally determined light output responses for NE-213 exposed to monoenergetic neutrons. The results of this code were compared to FERDOR unfolded ^{252}Cf and PuBe source spectra obtained with the calibrated KSU two inch spectrometer. Absolute calibration of the aqueous media spectrometer was effected with a standard ^{252}Cf source. The spectrometer developed was used to determine the fast neutron spectrum in a small mock-up of the KSU Triga reactor core. This spectrum is compared to the fast beam port spectrum for this reactor and the latter is shown to be a hardened fission spectrum. (Diss. Abstr. Int., B)

17855 MONTE CARLO CALCULATION OF THE RESPONSE OF A COLLIMATED SODIUM IODIDE GAMMA-RAY SPECTROMETER TO PLANE SOURCES OF RADIATION. Urban, William Thomas. Manhattan, Kan.; Kansas State Univ. (1971). 206p. University Microfilms Order No. 72-1803.

Thesis.

A Monte Carlo computer code was developed for determining the response of a lead collimated sodium iodide scintillation detector to plane sources of gamma radiation. The code is applicable in the energy range of 0.010 to 1.25 MeV for rectangular plane sources of monodirectional, isotropic and powers of cos θ source angular distributions. Simulation of the detector response was effected through the use of analogue techniques with biasing in following the gamma rays from the source to the detector. Upon entering the detector, survival weights were utilized in determining the gamma-ray energy loss to the detector. The accuracy of the code was demonstrated for the isotropic case by a comparison of calculated and experimental response functions. The comparison was favorable. It was found that the response functions have a slowly varying dependence on plane source angular distribution. Comparison of integrated response functions for the isotropic and powers of cos θ cases indicated a difference of less than two per cent. For the cos θ case, the integrated response function values had decreased in magnitude by ten to fifteen per cent in comparison to the isotropic case values. This decrease in magnitude is a function of the source energy and becomes more predominant as the energy increases. The contributions of collimator interacted radiation (source gamma rays which were initially incident on either the collimator barrel wall or the collimator face) to the system response were also calculated. The variation of the collimator interacted radiation contribution to the system response was shown to be a function of both source energy and angular distribution. (Diss. Abstr. Int., B)

17856 Ge(Li) GAMMA-RAY SPECTROMETER OF HIGH SENSITIVITY AND RESOLUTION FOR BIOLOGICAL AND ENVIRONMENTAL COUNTING. Phelps, Paul L.; Hamby, Keith O.; Shore, Bernard; Potter, Gilbert D. (Univ. of California, Livermore). Advan. Chem. Ser.; No. 93, 202-30(1970).

From Meeting on radionuclides in the environment; San Francisco, Calif. (1 Apr 1968).

A high resolution, anticoincidence-shielded, gamma-ray spectrometer has been developed to analyze complex, low level mixtures of gamma-emitting radionuclides in environmental and biological samples. The primary detector is a planar, lithium-drifted, germanium diode contained within a plastic annulus (76 cm × 76 cm). This configuration was found to reduce significantly the Compton background with a resultant improvement in detection of weak spectral lines. The sensitivity permits the detection of radionuclides in environmental samples at levels below 0.05 pCi/gram—e.g., 10 pCi of ^{137}Cs can be detected easily in 2 liters of cows' milk. Examples are presented of the spectral analysis of radionuclides in various biological and environmental samples contaminated with worldwide fallout, with debris from nuclear cratering experiments, or with reactor effluent. (auth)

17857 STABILIZED BOREHOLE GAMMA-SPECTROMETER. Bragin, A. A.; Korenev, D. P.; Blyumentsev, A. M.; (and others).

Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 7, 189-97(1969). (In Russian).

A spectrometer is described which provides undistorted transmission of the amplitude spectrum of the pulses of a detector to the panel at the surface, using any type of logging cable as the connecting line. Automatic gain control of the measuring circuit is used to stabilize the spectrometer according to a light market signal. The information pulses are analyzed, in discrete and continuous measurements by two differential channels and an "ordinary" counting channel; it is possible to record values of the ratio of readings observed on different channels. The spectrometer was tested on models and in wells. (Geophys. Abstr.)

17858 ESTIMATION OF THE EFFICIENCY OF A DUAL BOREHOLE GAMMA SPECTROMETER. Nedostup, G. A.; Nikulin, B. A. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 7, 197-203(1969). (In Russian).

Two variations of the construction of three crystal sensors for a dual borehole γ spectrometer are examined with respect to their counting efficiency. Approximate expressions are derived and the efficiencies of these variations are calculated for different sizes of scintillators. It is found that sensors with the auxiliary crystals located on the axis are several times more effective than these in which the auxiliary crystals are radially located. (Geophys. Abstr.)

17859 IMPROVEMENT OF γ AND X RAY COMPTON SUM SPECTROMETRY USING SUPERFLUOUS DATA. Etienne, M. (Laboratoire Central de l'Armement, Arcueil, France). Rev. Phys. Appl.; 6: No. 3, 313-18(Sep 1971). (In French).

The summing Compton spectrometer does not necessarily utilize the Compton scattering equation. Nevertheless, if this equation is used, more accurate results can be obtained; a computer is necessary in this case. (France)

17860 POLYGONAL-SHAPED RADIATION DETECTOR EMPLOYING PLURAL PRISM-SHAPED SEMICONDUCTOR CRYSTALS. Cacheux, Jean Antoine; Meuleman, Johannes (to U. S. Phillips Corp.). U. S. Patent 3,621,256. 16 Nov 1971. Priority date 19 Feb 1968, France.

A semiconductor detector for measuring and/or detecting ionizing radiation is described. The detector has a large sensitive volume and is designed particularly for gamma spectrometry. (auth)

17861 FOCAL PLANE SLOPE OF A HOMOGENEOUS MAGNETIC SECTOR. Chavet, I. (Soreq Nuclear Research Centre, Yavne, Israel); Menat, M. Nucl. Instrum. Methods; 99: No. 1, 115-19(1972).

An explicit expression for the focal plane slope is derived for the case of a homogeneous magnetic sector with oblique incidence and emergence and curved field boundaries. Several examples are given. When effective field boundaries are considered, secondary effects of the fringe-field are negligible, as is confirmed by a ray-tracing program. (2 figures) (auth)

17862 VERSATILE Ge(Li)–NaI(Tl) COINCIDENCE–ANTICOINCIDENCE GAMMA-RAY SPECTROMETER FOR ENVIRONMENTAL AND BIOLOGICAL PROBLEMS. Cooper, J. A.; Perkins, R. W. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Nucl. Instrum. Methods; 99: No. 1, 125-46(1972).

A high-sensitivity gamma-ray spectrometer incorporating a high-performance Ge(Li) detector and a NaI(Tl) well detector was developed which provides improved sensitivities for both coincident and noncoincident gamma-emitting radionuclides. It provides about a 10-fold reduction in the smooth portion of the natural background interference while Compton interferences are reduced by as much as 85 times in the anticoincidence spectrum and 400 times in some coincidence spectra. The Compton edge of ^{137}Cs is reduced by a factor of 18 in the anticoincidence spectrum to yield the highest reported peak-to-Compton-edge ratio of 790 : 1 and 915 : 1 peak-to-Compton-minimum. Its sensitivity for measuring most radionuclides in many environmental and biological samples is about 1 dpm including such coincident gamma-emitting radionuclides as ^{22}Na, ^{46}Sc, and ^{60}Co. Examples of its radioanalytical applications are illustrated and discussed. (18 figures, 5 tables) (auth)

17863 INTERACTIONS OF Ge(Li) DETECTORS AND ION PUMPS. I. OBSERVED PHENOMENA. Fouarge, J.; Delporte, R. (Univ., Liege). Nucl. Instrum. Methods; 99: No. 1, 81-92 (1972). (In French).

In experimental work on the preparation of Ge(Li) detectors, the vacuum for the cryostat was maintained by a small titanium ion pump. Degradation of spectroscopic characteristics due to the increase of the diode reverse current in a matter of hours, or days, after the chemical treatment was observed. It was found that the influence, sometimes enormous, of the ionic discharge on the reverse current of the detector is a consequence of the adsorption of some "activated" gases released by the pump and that these frequently deleterious, but occasionally beneficial, electrical effects so obtained are reversible by vacuum heating of the crystal "in situ." (12 figures) (auth)

17864 USE OF POSITION-SENSITIVE SEMICONDUCTOR DETECTORS IN THE STUDY OF HEAVY ELEMENT NUCLEAR REACTIONS. Minor, M. M. (Univ. of Maryland, College Park); Salwin, A. E.; Viola, V. E. Jr.; Theus, R. B.; Bondelid, R. O. Contract AT(40-1)-3783. Nucl. Instrum. Methods; 99: No. 1, 63-72(1972).

The application of position-sensitive semiconductor detectors to the study of heavy-element nuclear reactions at intermediate energies is described. Experimental procedures and results are presented for the use of these devices in the following types of measurements: binary fission fragment angular correlations, fission fragment angular distributions, kinetic energy release in fission, and spallation recoil product angular distributions. The position-sensitive detectors are found to provide much-improved experimental efficiency over normal semiconductor detectors in experiments where the angular dependence of the products is quite strong, e.g. fission fragment angular correlations and spallation recoil angular distributions. For experiments in which the product counting rates vary slowly with angle, such as fission fragment angular distributions, the position detector is much less useful. Although the energy resolution of these devices is poorer than normal detectors, they are advantageous in experiments designed to study fission energetics as a function of reaction kinematics. (8 figures) (auth)

High Energy Physics Instrumentation

17865 (ANL/HEP–7140) EFFECT OF BREMSSTRAHLUNG ON THE MEASURED CURVATURE OF CHARGED PARTICLE TRACKS. Prastein, S. Matthew (Argonne National Lab., Ill.). 27 Sep 1971. 13p. Dep. NTIS.

Estimates are derived for the effect of bremsstrahlung on the measured average curvature of bubble chamber tracks, and for the bias introduced by rejection of tracks with large variation of curvature. (auth)

17866 (ISS–71/15) DIGITIZED PROTON RANGE SPARK CHAMBER BETWEEN 60 AND 150 MeV. Giordano, R.; Grisanti, G.; Salvadori, P. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 16 Jul 1971. 62p. (In Italian). Dep. NTIS (U. S. Sales Only).

A multiplate range spark chamber for protons is described. The digitizing system and the particular criteria adopted for track reconstruction are outlined. Preliminary results with cosmic rays were obtained using an automatic data acquisition system by means of an on-line IBM 1800 computer. (auth)

17867 (ITEF–806) STORAGE TIME IN A WIRE SPARK CHAMBER. Kanavets, V. P.; Martynov, V. I.; Ryl'tsov, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that the dependence of the efficiency of a spark chamber with wire electrodes on the delay time can have slowly dropping tails because of the diffusion of ions through the electrodes. Methods of correction of this characteristics are presented. (tr-auth)

17868 (ORO–2504-173) WIRE-WINDING AND TENSIONING MACHINE FOR THE CONSTRUCTION OF PROPORTIONAL WIRE PLANES AND WIRE SPARK CHAMBERS. Technical Report 72-004. Michener, J.; Zorn, G. T. (Maryland Univ., College Park, Dept. of Physics and Astronomy). Jul 1971. Contract AT(40-1)-2504. 13p. Dep. NTIS.

The design and operation of a machine for the laying of wires at equal spacing and tension to form wire planes for wire spark chambers are described. (W.H.K.)

17869 (ORO–2504-176) COMPACT HIGH SPEED LOW IMPEDANCE BLUMLEIN LINE FOR HIGH VOLTAGE PULSE SHAPING. Technical Report No. 72-029. Crouch, J. H.; Risk, W. S. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Oct 1971. 23p. Dep. NTIS.

Design, construction and operation of a low impedance Blumlein line are presented. Glycerol was used as a dielectric to obtain a 14-½ ohm line which in conjunction with a Marx generator driver could produce 5 nsec long 240 kV pulses. The line, which is small enough to be housed in a Lucite box 12 in. wide × 12 in. long × 5 in.

thick, was used to drive a bank of four 7 ft. long × 1 ft. wide × 3 in. gap streamer chambers. Properties of the Blumlein with water as the dielectric are also given and limitations on further shortening of the pulse are discussed. (auth)

17870 (ORO-2504-178) PERFORMANCE OF A BANK OF FOUR 7 FT. STREAMER CHAMBERS. Technical Report No. 72-032. Crouch, J. H.; Risk, W. S. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Oct 1971. 31p. Dep. NTIS.

A bank of four 3 in. gap × 12 in. wide × 7 ft. long streamer chambers surrounding a one atmosphere hydrogen gas target used in an experiment to measure the threshold cross-section for the reaction $\pi^+p \rightarrow \pi^+\pi^+n$ is described. Details of construction and operation are presented and photographs of representative tracks are included. (auth)

17871 APPLICATION OF HOLOGRAPHIC INTERFERENCE TO BUBBLE CHAMBER PHOTOGRAPHY. Gan, W. S. (Nanyang Univ., Singapore). Phys. Lett.; 38A: No. 4, 253-4(14 Feb 1972).

Applying holographic interference using linearly polarized light to bubble chamber photography, one can improve the precision of bubble size measurement and improve the contrast and resolution of adjoining bubble tracks. (auth)

17872 HIGH-ENERGY NEUTRON HODOSCOPE USING MULTIWIRE PROPORTIONAL CHAMBERS. Coignet, G. (Institut de Physique Nucleaire, Orsay, France); Massonnet, L.; Minnard, M. N.; (and others). Nucl. Instrum. Methods; 99: No. 1, 19-24(1972).

A high-energy neutron hodoscope is presented where the impact vertex of the neutron is determined by detection of charged particles produced in a converter, with two multiwire proportional chambers. Tests in 19-GeV/c neutron and 10-GeV/c proton beams give, for a total neutron efficiency of 6.5%, an accuracy of ±2.2 mm. Of the reconstructed events 96% are found within ±1 cm distance from the true impact point. The efficiency is then six times larger for neutrons than for gamma rays. (6 figures, 2 tables) (auth)

17873 INSENSITIVITY TO COSMIC RAYS OF THE GRAVITATIONAL RADIATION DETECTOR AND A SEARCH FOR π^0 PRODUCTION IN SPONTANEOUS FISSION OF ^{252}Cf. Ezrow, David Howard. College Park, Md.; Univ. of Maryland (1971). 130p. University Microfilms Order No. 72-2589.

Thesis.

A search for coincidences between cosmic ray shower signals in a large scintillation counter and gravitational radiation detector signals indicates that the gravitational-radiation-detector does not produce a signal when hit by showers of particle density of the order of 300 charged particles per square meter. There is no evidence of a time correlation between large shower arrivals and 2-fold coincident gravitational-radiation-detector signals. The branching ratio of π^0's produced with fission to total fission was measured for spontaneously fissioning ^{252}Cf. The measurement was $(-2.3 \pm 3.0) \times 10^{-6}$, which sets an upper limit for the process. The sensitivity of the measurement is limited by the background counting rate in comparison with the strength of the ^{252}Cf source. The background is attributed to extensive air showers. (Diss. Abstr. Int., B)

Radiometric Instruments

17874 IMPROVEMENT OF VERTICAL RESOLVING POWER OF A FIELD NEUTRON HYGROMETER. Beskin, L. I.; Bogdanov, I. Ya.; Emel'yanov, V. A.; Kiyanya, S.; Sinitsyn, V. I. At. Energ. (USSR); 31: No. 5, 527-30(Nov 1971). (In Russian).

The probe of a hygrometer was designed with a boron-filled counter and a Pu + Be source which yielded 10^5 n/sec, and a partial Cd shield. Experiments were conducted with such a probe immersed in wet sand, and the count rate of slow neutrons was determined as a function of the relative distance of the probe from the center of the sand bed. (K.S.W.)

17875 DETERMINATION OF SEVERAL PARAMETERS OF A MONITORABLE MEDIUM FROM THE γ RADIATION DURING INELASTIC SCATTERING OF FAST NEUTRONS. Pozdneev, D. B. (Gorky State Univ., USSR). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 1, 53-4(Jan 1971).

Translated from Zavod. Lab.; 37: No. 1, 43-4(Jan 1971).

An apparatus for measuring the inelastic scattering of fast neutrons that may be used for thickness measurements is described. Thickness measurements of steel foils and steel foils with carbon backings can be accomplished, and the boundaries of layers of two different substances can be measured. (W.H.K.)

17876 STANDARDIZATION SYSTEM FOR A DIGITAL RADIATION GAUGE. Grant, Michael P. (to Industrial Nucleonics Corp.). U. S. Patent 3,612,876. 12 Oct 1971. Filed 21 May 1968.

A system for measuring weight per unit area using a nucleonic gauge with simplified standardization circuits is described. In one embodiment the standardization circuitry is all digital, and in another embodiment it is partially digital. In those two embodiments and a third embodiment the standardization circuitry is operated in accordance with the count of detector output pulses occurring during a predetermined interval during a standardization time. In the latter embodiment, this digital count signal is converted to an analog signal to vary the operating point pulse rate directly and the counting time inversely. In the other two embodiments, the digital count signal is employed to set a down counter to the corresponding count, and then the counter counts down for an interval of time. In one embodiment the analog of the digital count signal is employed to determine the count down time, while another embodiment utilizes the digital count signal itself to establish that count down interval. (auth)

17877 THICKNESS GAUGES WITH RADIOISOTOPES IN ROLLING MILLS. Bierwolf, H. Berg- Huettenmaenn. Monatsh.; 116: No. 1, 21-4(Jan 1971). (In German).

Measuring equipment is described, which is used for control of thickness in the production process of sheet iron and steel tubes. The described apparatus is a transmission gauge consisting of a gamma-emitter (^{60}Co, ^{137}Cs, or ^{241}Am is used depending on the thickness of the product) and an ionization chamber. The desired thickness value of the product is set on the gauge; in this case the reading is zero. The occurring deviations can be directly taken from the reading. Necessary corrections in case of the radioactive decay or contamination in the path of the gamma-rays are always automatically performed when there is no material in the gauge. (INIS)

17878 USE OF NUCLEAR RADIATION TO MEASURE LOCAL MOISTURE CONTENT DURING DRYING. Hatcher, J. D. (Clemson Univ., S. C.); Lyons, D. W.; Sunderland, J. E. Int. J. Appl. Radiat. Isotop.; 23: No. 1, 40-3(Jan 1972).

The measurement of local values of the moisture content is essential for the experimental analysis of heat and mass transfer processes. To make such measurements of drying materials under conditions where it is impossible to insert a probe into the sample without disturbing the sample or the environment surrounding the sample, a method using a gamma-ray beam is considered. The relationship between the attenuation of a photon beam and the moisture content of the material through which it passes is given. The experimental equipment used for measurements on meat and textiles is presented, and the results obtained during freeze-drying and microwave drying are examined. (UK)

17879 DETERMINATION OF LIGHTER IMPURITIES ON SILICON BY 90° FORWARD ION SCATTERING THROUGH THIN TARGETS. Meek, R. L.; Gibson, W. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Nucl. Instrum. Methods; 98: No. 2, 375-7(1972).

Ion scattering is shown to be a sensitive technique for determination of lighter than substrate impurities when thin samples are used and particles scattered 90° through the sample (90° forward) are analyzed. The method is applied to the determination of carbon on silicon. The sensitivity is estimated to be a few monolayers. (auth)

17880 ACCURAY KET PROCESS: A NEW STANDARD FOR NONDESTRUCTIVE IDENTIFICATION OF MICROIMPERFECTION. Eddy, William C. Jr. (Industrial Nucleonics Corp., Columbus, Ohio). Anal. Instrum.; 8: VII.1.1-5(1970).

From sixteenth annual ISA analysis instrumentation symposium; Pittsburgh, Pa. (25 May 1970).

The AccuRay KET radiological gas inspection process has demonstrated remarkable (10^3) improvement in sensitivity over fluorescent penetrants for the measurement of microdefects in materials. The process is similar to a penetrant system. A radioactive gas (krypton 85) is caused to adsorb on all surfaces of the material. Defects, corrosion and porosity present significantly larger surface area and reduced desorption rates over that of the good surfaces. The presence of radiation is detected by using either a photographic film or a scintillation system. The residual radiation adsorbed on a part after the test is well below that which requires source licensing and can be reduced to a nondetectable level by a moderate application of heat. While current DOD interest is directed toward using the process as an improved crack detection system, longer range applications include actual fatigue life determination. The technique has shown itself capable of measuring low cycle fatigue

in rotating parts at a time as low as 30% of the fatigue life of a material. (auth)

17881 NUCLEAR ABSORPTION SULFUR ANALYZER. Palmer, M. N.; Rhodes, D. F.; Puzniak, T. J. (Gulf Research and Development Co., Pittsburgh). Anal. Instrum.; 8: VII.2.1-7(1970).

From sixteenth annual ISA analysis instrumentation symposium; Pittsburgh, Pa. (25 May 1970).

A nuclear absorption sulfur analyzer designed by GR&DC measures sulfur in the range of 0% to 10.0% by weight in liquid hydrocarbon process streams. The measurement is made by the X-ray absorption method using a long half-life radioisotope as the source of the X-rays. The X-ray source used in the analyzer enables the sulfur measurement to be made independently of the hydrogen-carbon ratio of the oil being analyzed while its long half-life minimizes calibration adjustments to the analyzer due to decay of the source. A system to continuously compensate for oil density changes is incorporated to insure that the sulfur measurement is independent of oil density variations. Modifications of the basic analyzer to pilot plant and laboratory operations are also described. (auth)

17882 RADIOISOTOPE X-RAY FLUORESCENCE ANALYSIS. Berry, Peter F. (Nuclear Chicago Corp., Austin, Tex.). Anal. Instrum.; 8: VII.3.1-16(1970).

From sixteenth annual ISA analysis instrumentation symposium; Pittsburgh, Pa. (25 May 1970).

X-ray fluorescence techniques employing radioisotope sources to stimulate characteristic X-ray emission, and non-dispersive methods of X-ray energy selection and measurement, are described. Instruments which incorporate these techniques are also described and illustrative examples of applications, covering a broad industrial spectrum are given. The advantages of radioisotope X-ray fluorescence stem mainly from the radioisotope source. Its small physical size and essentially constant emission, independent of external power and other physical influence, lend to compact, reliable and portable instrument design. Many applications not before feasible such as analyses in the field and on the factory floor are now possible and have successfully been demonstrated. (29 references) (auth)

17883 RADIOMETRIC ANALYSIS OF BULK MATERIAL BY THEIR SPECIFIC WEIGHT. Kubicek, P.; Mrazek, L. (Berg- und Huettenmaennische Hochschule, Ostrava, Czech.). Isotopenpraxis; 7: No. 8, 326-35(Aug 1971). (In German).

A method for continuous determination of the specific weight of a material, which changes during measurement, is presented. The method is based on a combination of absorption and scattering of radiation in the energy range, within which the Compton effect is predominant. The experimental investigation was performed on coal and country rock. A description is presented of a radiometric device whose signals can be used to control a mechanical attachment serving for automatic separation of two kinds of bulk material having different specific weight. (auth)

17884 MODULAR SYSTEM OF RADIOMETRIC INSTRUMENTS FOR INDUSTRIAL MEASUREMENT AND CONTROL. Kubalek, Jiri (Research Inst. of Nuclear Instrument Construction, Premysleni, Czech.). Jad. Energ.; 17: No. 10, 330-3 (Oct 1971). (In Czech).

The basic concept of a block system of radioisotopic equipment with ionization chambers designed chiefly for measurement and regulation in industry is described. A list of available modules is given, together with interconnection possibilities. (tr-auth)

17885 PROCESS AND APPARATUS FOR DEFECT DETECTION USING A RADIOACTIVE ISOTOPE. Eddy, William Jr. (to Industrial Nucleonics Corp.). U. S. Patent 3,621,252. 16 Nov 1971. Filed 28 Nov 1969.

Detection of defects such as cracks, and the like, is accomplished by effecting adsorption of an inert gas radioisotope, e.g., krypton-85, onto the surface to be examined followed by obtaining a visible image of the radioactivity level pattern prior to desorption of the adsorbed gas. Prior to adsorption, the surface is outgassed to remove occluded gases, followed by exposure to the inert radioactive gas at essentially ambient temperature and pressure in the range of 2 mm Hg to one atmosphere above 760 mm Hg. Visible images are obtained by use of fiber optics in bundle form; the fibers are coated with a phosphor which emits light when exposed to the inert gas radioisotope. The bundle of fibers has a front face which conforms to the surface of the part examined, the light output being fed to a video camera whose output signal is amplified and displayed on a video display device. (auth)

17886 NEW DEW-POINT HYGROMETRY MAKING USE OF β-RAY SCATTERING. Kobayashi, Hisanobu; Matsumoto, Shigeaki; Yamanouchi, Masahide; Toyohka, Satoru (Saitama Univ., Urawa, Japan). Radioisotopes (Tokyo); 20: No. 12, 655-9(Dec 1971).

The present hygrometer is devised on the principle that the β-ray scattering by the metal surface decreases when the surface is covered by dew. This decrease of β-ray scattering is caused by the decrease of the effective atomic number of the scattering surface material. Carbon-14 and gold plate were used as the β-ray source and the metal, respectively. The counting rate due to scattered β rays and the temperature of the plate surface were recorded against time. The two temperatures at which the dew begins depositing and disappearing were detected in the experiments and decided the same dew-point. This hygrometer is useful to prevent supersaturation, because numerous condensation nuclei are formed by β rays and the rough finish of the plate surface makes the formation of dew easy. The hygrometer is also free from the errors owing to the incidental rise of the surface temperature caused by illumination which is indispensable for the mirror type hygrometer. The dew-point could be measured to an accuracy of 0.5°C, i.e., 2% in humidity, at room temperature. (auth)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

17887 (SC-RR-710744) NEUTRON DAMAGE ANNEALING IN SILICON n-CHANNEL JUNCTION FIELD EFFECT TRANSISTORS. Gregory, B. L. (Sandia Labs., Albuquerque, N. Mex.). Oct 1971. 10p. Dep. NTIS.

Neutron damage annealing studies have been performed in n-channel, epitaxial silicon JFET's. Measurements of the parameters g_{msat}, I_{DSS}, and V_{PO} have been made as a function of neutron fluence in devices with various phosphorous concentrations in the channel region. The recovery in device parameters during isochronal annealing exhibits a significant dependence on both the exposure fluence and the phosphorous concentration. The fluence dependence is due to the non-linear relationship between device parameters and defect concentration. The dependence on the phosphorous concentration is thought to be caused by E-center formation and break up during neutron damage recording. The recovery observed in the JFET's during annealing occurs at temperatures which are commonly reached during normal operation of power devices. Hence, significant self-healing of damage may occur during operation of such devices. (auth)

17888 (SC-RR-710853) TRANSIENT AND PERMANENT RADIATION EFFECTS IN BARITT MICROWAVE OSCILLATORS. Chaffin, R. J. (Sandia Labs., Albuquerque, N. Mex.). Jan 1972. 57p. Dep. NTIS.

The effect of neutron fluence as well as transient ionizing radiation on the BARITT (BARrier Injection Transit Time) microwave oscillator is studied both theoretically and experimentally. The results show that a 5 GHz device can tolerate a neutron fluence of 10^{15} nvt (n/cm^2, E > 10 keV) and still operate satisfactorily. The eventual device failure with neutron fluences above this level is found to follow one of two paths: (1) Trapped holes in the space-charge region add to the ionized donor density and increase the internal electric field to the point of avalanche breakdown; (2) A negative temperature coefficient $V^{-1}\partial V\ \partial T$ of the device caused by increased emission rates of the trapped holes with increasing temperature can lead to dc burnout. The study derives the neutron failure fluence for BARITT devices in general. The study also shows theoretically and experimentally that a 5 GHz BARITT stops oscillating briefly when exposed to ionizing radiation rates greater than 5×10^8 rad/sec. An equation is also derived which gives the ionizing radiation interruption level for BARITT's in general. (auth)

17889 SILICON SOLAR CELL ARRAY HARDENED TO SPACE NUCLEAR BLAST RADIATION. Wise, Joseph F. (to Secretary of the Air Force). U. S. Patent 3,620,847. 16 Nov 1971. Filed 5 May 1969.

A silicon solar cell array having the substrate, the cell-supporting grid structure, the electrical connecting leads, the cell contacts, and the terminal connections all fabricated from low atomic material such as aluminum, beryllium, or magnesium; having glass, silicon oxide and anodized aluminum insulation; silicone adhesives; and having ultrasonic welded electrical connections that provide a hardened silicon solar cell array that is

relatively impervious to damage from space nuclear blast radiation is described. (auth)

17890 EFFECT OF NEUTRON IRRADIATION ON THE CURRENT-VOLTAGE CHARACTERISTIC OF AN n-Ge–n-Si ISOTYPIC HETEROJUNCTION. Fedotov, Ya. A.; Gruzdeva, G. A.; Uvarov, E. F. (Moscow Inst. of Steel and Alloys). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 5, 852-3(Nov 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 5, 966-7(May 1971).

Two n-Ge/n-Si heterojunctions with different interface densities of states and current–voltage characteristics (rectification and saturation, respectively) were irradiated with neutrons to a dose of 10^{16} n/cm^2. The irradiation of the first junction reduced the forward voltage drop but increased the forward and reverse currents. For the second junction, the current was also increased in the low-voltage range but reduced at high bias, with a raised breakdown voltage. These changes were due to defect levels at $E_c - 0.40$ eV in Si and $E_c - 0.20$ eV in Ge. (D.L.C.)

17891 TEMPERATURE DEPENDENCE OF PHOTOCURRENTS PRODUCED BY X AND GAMMA RAYS IN SILICON RADIATION DETECTORS. Scharf, Karl; Mohr, Robert K. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 75A: No. 6, 579-89(Nov-Dec 1971).

The temperature dependence of dc photocurrents produced by x and gamma rays in silicon radiation detectors of the n-p, p-i-n, and surface-barrier type was investigated in a temperature range between 20 and 50°C. Photodiode photocurrents, assumed as being equal to the generated currents I_g, showed a positive temperature dependence in all detectors investigated. Their temperature coefficient at 25°C varied between +0.004 and +0.002 per °C. The temperature dependence of short-circuit currents I_{sc} measured by a compensation method was positive and nearly linear for n-p type detectors but nonlinear and negative for p-i-n and surface-barrier type detectors. It is shown, that this different behavior of individual detectors is due to the influence of the strongly temperature-dependent junction current I_j which under the short-circuit mode is drained off the generated current I_g. The junction current is a function of the internal series resistance R_s and the junction resistance R_j of the irradiated detector ($I_j = I_{sc} R_s/R_j$). With increasing resistance ratio R_s/R_j, the current ratio I_j/I_g increases and the temperature coefficient α_{sc} of the short-circuit current decreases. Temperature coefficients $(\alpha_{sc})_{25}$ measured in the different detectors at 25°C and a current density 6×10^7 A/cm^2 decreased with increasing resistance ratio from +0.004 to −0.005 per °C. Resistance ratios R_s/R_j of the detectors investigated ranged between 0.01 and 0.24 approximately. Thus, $(\alpha_{sc})_{25}$ measured in an individual detector can be changed by changing its effective series resistance. A decrease of $(\alpha_{sc})_{25}$ with increasing I_{sc} was observed in detectors with larger resistance ratios. This was apparently due to the voltage dependence of R_j at higher junction voltages produced by large short-circuit currents. (auth)

17892 RADIATION-INSENSITIVE VOLTAGE STANDARD MEANS. Lesk, Israel Arnold (to Motorola, Inc.). U. S. Patent 3,617,829. 2 Nov 1971. Filed 1 Dec 1969.

A diode which is used as the forward-biased element of a pair of series-connected diodes comprising a zero temperature coefficient voltage standard means is hardened against irradiation by neutrons. The diode can take one of several forms. These forms include diodes having thin bases and high recombination surfaces, transistors each having a plurality of collectors, each shorted to the base thereof four-layer semiconductor elements in which the middle two layers are very thin. In each case, the excess number of minority carriers is kept constant for a given current through the forward-biased element, resulting in an unchanged voltage drop at a given current after neutron irradiation. (auth)

17893 NUCLEAR HARD VIDEO AMPLIFIER. Oelke, Harlan J. (to Secretary of the Army). U. S. Patent 3,619,799. 9 Nov 1971. Filed 22 Jan 1970.

A video amplifier circuit which exhibits stability of gain under neutron bombardment is described. Nuclear radiation in the order of 10^{18} neutrons/cm^2 (nvt) causes changes up to 90% in transistor beta. The amplifier includes a bias circuit for compensation of the beta change to maintain near constant gain. (auth)

17894 INTENSE IONIZING RADIATION EFFECTS ON SILICON SEMICONDUCTOR DEVICES. Baltateanu, N. (Inst. of Atomic Physics, Bucharest); Niculescu, A. Rev. Roum. Phys.; 16: No. 8, 841-53(1971).

A simple technique for studying the quasi-permanent effects of irradiation on semiconductor devices and observations on the variation of electrical parameters due to irradiation and thermal treatment is presented. Experiments with the "IAP linear 3-MeV electron accelerator" are described. Samples were low-frequency and low-power double-diffused silicon n–p–n encapsulated planar transistors. The irradiation temperature was 10°C to 12°C, all measurements being performed at room temperature; the thermal-treatment temperature ranged between 100°C and 300°C. All the changes of the parameters (U_{EBO}, U_{CBO}, U_{CEO}, I_{EBO}, I_{CBO}, β, t_s, t_f) occurred in the absorbed dose range of 10^5 to 10^9 rad. (7 figures, 1 table) (auth)

17895 RADIATION-HARDENED PULSE-PRODUCING SYSTEM. Pritchard, Eric K. (to Secretary of the Navy). U. S. Patent 3,618,127. 2 Nov 1971. Filed 18 Jul 1969.

A radiation-hardened pulse-producing system having an oscillator, a buffer amplifier and a saturable core transformer for producing output pulses is described. Current feedback loops from the output winding of the transformer to the input winding of the transformer, including blocking oscillators, insure at least a predetermined time delay between output pulses will be maintained if the system is subjected to a radiation environment. (auth)

17896 NEUTRON DAMAGE IN GaP LIGHT-EMITTING DIODES. Barnes, C. E. (Sandia Labs., Albuquerque, N. Mex.). Appl. Phys. Lett.; 20: No. 3, 110-12(1 Feb 1972).

The effects of neutron damage on the red and green light output at 300°K of GaP light-emitting diodes have been examined. The results indicate that the diodes are not sensitive to neutron irradiation in those voltage regions where the radiative current is due to space-charge recombination in the depletion layer. As a consequence of this, it is shown that the response of the diodes to neutron irradiation can be used to elucidate the radiative current-flow mechanisms in these devices. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 17836 and 19636.

17897 (GULF-GA-A-10864) RELIABILITY ANALYSIS OF HIGH TEMPERATURE THERMOCOUPLES IN IRRADIATION CAPSULES. Jacobsen, F. K.; Sandefur, N. L.; Grenda, R. J. (Gulf General Atomic Co., San Diego, Calif.). 27 Oct 1971. Contract AT(04-3)-633. 23p. Dep. NTIS.

In conjunction with nuclear fuels development testing being conducted by Gulf General Atomic, data were recorded for 571 thermocouples used to monitor temperatures of the test capsules. Analysis of the data indicates that thermocouple reliability is primarily a function of: 1. The material used to make the thermocouple. 2. The temperature at which the thermocouple operates. 3. The intensity of the neutron flux field to which the thermocouple is exposed. There is no indication that an endurance limit is being approached in testing durations up to 6000 hours and 6×10^{21} fast neutrons per square centimeter (E > 0.18 MeV). Average values of mean time between failures (MTBF) are tabulated. (auth)

17898 (ORNL-tr-2545) EFFECT OF INDIVIDUAL FACTORS ON THE EFFICIENCY OF LUMINESCENT SCREENS FOR NEUTRON RADIOGRAPHY. Nikishov, V. S.; Gurvich, A. M.; Tyufyakov, N. D.; Shtan, A. S.; Yaskevich, V. S. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Radiats. Tekh.; No. 6, 58-62(1971). 6p. Dep. NTIS.

The results of studies on the effects of various factors on the efficiency of ZnS·Ag luminescent screens to be used with x-ray film in neutron radiography are presented. Screen preparation, optimum screen thickness, and the method of introduction and amount of boric acid were studied. (W.H.K.)

17899 (UCRL-73482) COMPUTER-CONTROLLED THIN-FILM MATRIX IMAGE-DIGITIZING SYSTEM. Martin, L.; Gadd, T.; Baker, T. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Oct 1971. 9p. (CONF-711111-34). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A large amount of nuclear test and simulation data is in the form of single-transients which might be in the picosecond to microsecond range and which ordinarily are recorded with an oscilloscope and high-speed film system. The requirement to analyze large quantities of film, the desire to remove the human factor in the data analysis process, as well as to experiment with image processors in an interactive or remote time-shared computer environment, have prompted the approach to a computer-controlled image-digitizing system that is described. The system is based on a photo-matrix controlled by a small DEC PDP-8 computer. Selected portions of the system and its principal components are described. (auth)

17900 MAGNETIC FIELD OF STEPPED PLANE-PARALLEL POLE PIECES. Bogomolov, E. A.; Saulit, V. R. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 860-3(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1088-92(Jun 1971).

The magnetic field produced by a pair of plane-parallel pole pieces with inner rectangular steps is found using the method of conformal mapping. The size of the step is arbitrary. The fields produced by stepped pole pieces are used in the spectrometry of heavy charged particles. (auth)

17901 HIGH STABILITY SMALL CURRENT GENERATOR. Dalmazzone, Jean (Commissariat a l'Energie Atomique). French Patent 2,058,503. 3 May 1971. Filed 11 Sep 1969. (In French).

A small current (10^{-9}A or less) generator is described. It consists of a current ionization chamber with an electrode housing a long half-life radioactive source, a collector electrode divided into several mutually isolated parts, and a highly insulated selector allowing one or several parts of the collector electrode to be connected to the current output and a source, which establishes a potential difference between the first electrode and one or more of the different parts of the collector electrode which are connected together at the output. Generators of this type are used for measurements made in conjunction with radioactive sources, the half-lives of radioactive elements, and in controlling the response of ionization chambers. (France)

17902 PROCEEDINGS OF THE 16th ANNUAL ISA ANALYSIS INSTRUMENTATION SYMPOSIUM, PITTSBURGH, PENNSYLVANIA, MAY 25-27, 1970. Borchers, C. E.; Fowler, Lewis; McNiell, G. A. (eds.). Anal. Instrum.; 8: II.1.1-XI.1.1-3(1970). (CONF-700566).

Separate abstracts were prepared for 4 of the 37 papers presented. The remaining 33 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 17880–17882 and 19464.

17903 MOGA 70. Eighth International Conference on Microwaves and Optical Generation and Amplification, Amsterdam, September 7–11, 1970. Deventer, Netherlands; N.V. Uitgeversmaatschappij Kluwer (1970). 682p. (In several languages). (CONF-700914).

Separate abstracts were prepared for 2 of the 135 papers presented. The remaining 133 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 19176 and 19495.

17904 CALIBRATION OF PRESSURE GAGES DOWN TO 10^{-15} mm Hg BY MEANS OF AN IDEAL CONDENSATION PUMP. Grishin, S. F.; Grishina, E. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1199-1201(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1528-30(Jul 1971).

A method of calibrating pressure gages by using the vapor pressure of substances is discussed. The design of a simple instrument for calibrating hydrogen pressure gages is described. A magnetron gage has been calibrated at 10^{-15} mm Hg. (auth)

17905 NEW METHOD FOR FOCUSING ION BUNCHES IN TIME-OF-FLIGHT MASS SPECTROMETERS. Karataev, V. I.; Mamyrin, B. A.; Shmikk, D. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1177-9(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1498-1501(Jul 1971).

A new electrostatic system is proposed for focusing in ion time-of-flight devices. Experiments show that the system provides a constant relative time-of-flight to within 10^{-4} with a few percent spread in initial ion energies. (auth)

17906 NUCLEAR INSTRUMENT SYSTEM FOR WORK WITH COMPUTERS. Vojnovic, Mirko (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nukl. Energ.; 6: No. 1, 19-23 (1970-1971). (In Serbo-Croatian).

The development of electronic nuclear instrumentation in connection with the requirements, needs, and possibilities that computers may secure is discussed. The role and the place of the new system of electronic instruments designed for work with computers in real time is described. Typical functional modules are presented, and some examples of the application of the new system of electronic instruments are outlined. (auth)

17907 IONIZATION SOURCES IN MASS SPECTROMETRY. Chait, E. M. (Du Pont Instruments, Monrovia, Calif.). Anal. Chem.; 44: No. 3, 77A-80A; 82A; 84A; 86A; 88A; 91A(Mar 1972).

The present status and prospects for future development of ion sources for mass spectrometers are reviewed. Electron impact ionization, field ionization, chemical ionization, spark source ionization, surface ionization, and photo ionization are discussed. (W.H.K.)

17908 MODULAR SYSTEM OF NUCLEAR INSTRUMENTATION BASED ON THE CAMAC SYSTEM. Brantl, Karel; Svoboda, Arnost (Research Inst. of Nuclear Equipment Construction, Premysleni, Czech.). Jad. Energ.; 17: No. 10, 345-7(Oct 1971). (In Czech).

The advantages of the modular conception for nuclear technology are advanced, along with some international recommendations for standardization. The mechanical characteristics of the CAMAC system are described, and information is presented concerning a novel modular system developed by the corporate author. (tr-auth)

17909 MAINTENANCE OF APPARATUS IN THE ELECTRONIC EQUIPMENT STORE OF THE CENTRE D'ETUDES NUCLEAIRES AT SACLAY. Guyot, C.; Jouve, B. (CEA-CEN de Saclay, Gif-sur-Yvette, France). Maintenance; No. 15, 19-30(Sep 1971). (In French).

The maintenance of the very important store of electronic equipment at the Centre d'Etudes Nucleaires at Saclay is discussed. The store handles a large quantity of currently used equipment, a centralized rational system of maintenance has been organized for this equipment, which takes into account the various conditions under which the equipment is used. This system allows the GED (Testing and Repair groups) to ensure a mean working life of more than 5 years and a 99 per cent of the time availability for commonly used apparatus. If the widely differing times for which the various equipment is used is taken into consideration, the mean overall cost per year does not exceed the average 3 per cent of the value of the store. Without such an organized system the mean life of the equipment is 40 per cent less than that observed, the time for which the equipment is out of use is five times greater, and the equipment servicing costs are twice as high. (France)

17910 UNIVERSAL GONIOMETER FOR CHANNELING EXPERIMENTS. Schmid, K.; Mueller, H.; Ryssel, H. (Technische Univ., Munich). Nucl. Instrum. Methods; 99: No. 1, 121-4(1972).

A goniometer was designed to rotate a sample around four different axes. A horizontal shifting motion was also included, and provision for rotation of a cooled semiconductor detector around the scattering center was made. The movements are done by stepping motors and the pulses measured at the detector are correlated with a multichannel analyzer working in the multiscaling mode. The resolution of the equipment is 0.023°. The geometry of the goniometer provides an easy and exact adjustment of a crystal in respect to an ion beam. Two different adjustment procedures will be compared. (5 figures) (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 17618 and 17776.

17911 THIRD-ORDER ABERRATIONS IN THE MAGNETIC SECTOR FIELD. Nakai, Akira. Denki Shikensho Iho; 35: No. 8, 727-37(1971). (In Japanese).

In order to improve the performance of an electromagnetic mass separator, precise behavior of ion beams in the magnetic field of a sector-type mass analyzer has been studied by calculating geometrical aberrations of 2nd and 3rd orders using variation of constants in the case where the center ray of the beam enters into the magnetic field in parallel to the field boundary. In the vicinity of the image plane, the beam distribution by these aberrations is compared with the beam profile obtained by the use of graphite dry plates. Different from theoretical beam distribution in the geometrical optics, the actual one is rather symmetrical with respect to the axis and unsymmetrical to the image plane. These differences are thought to be caused by detection of the center ray of the beam by the fringing field. The center beam then enters the magnetic field at an angle to the normal of the field boundary. The beam is also influenced by the space charge of the other beams. (auth)

17912 OPTIMUM DESIGN OF STEP CASCADES FOR URANIUM ENRICHMENT BY GASEOUS DIFFUSION PROCESS. Higashi, Kunio; Saito, Toru; Doi, Hideo (Kyoto Univ.). Mem. Fac. Eng., Kyoto Univ.; 33: No. 3, 163-73(Jul 1971).

When the optimization of a step cascade is carried out directly on the basis of an exact formula, the calculus of minimization of a multi-variable function is essential. The numerical calculation is very complex and a brief estimation becomes impossible as the number of steps increases, because the number of variables in the calculus amounts to (2m-1) in all for an m-steps cascade. An approximate formula of good feasibility and sufficient accuracy has been proposed for the determination of the number of stages and interstage flow rate required for the plant of uranium enrichment by gaseous diffusion process. By using an approximate formula, the minimization of multi-variable function in the optimization of step cascades is to be avoided. The applicability of the proposed method was verified by the calculation of a typical plant for uranium enrichment. (auth)

Isotopic Power Sources

Refer also to abstracts 17644–17647, and 18275.

17913 (BNWL-1308-8) PACIFIC NORTHWEST LABORATORY, DIVISION OF ISOTOPES DEVELOPMENT PROGRAMS QUARTERLY REPORT: AUGUST-OCTOBER 1971. Jarrett, J. H. (comp.) (Battelle Pacific Northwest Labs., Richland, Wash.). Nov 1971. Contract AT(45-1)-1830. 45p. Dep. NTIS.

Research and development is reported on low cost Cs and Sr sources, large scale uses of fission-product Xe, isotope production and uses, neutron radiography using ^{252}Cf, advance source development, circulatory support systems, and nuclear methods for seabed exploration. (J.R.D.)

17914 (DP-1286) SAVANNAH RIVER LABORATORY ^{60}Co POWER AND HEAT SOURCES. Quarterly Progress Report, July-September 1971. Angerman, C. L. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov 1971. Contract AT(07-2)-1. 22p. Dep. NTIS.

The penetration of cobalt into the walls of inactive superalloy capsules, as measured with the electron microprobe, ranged from 0.011 in. in a Haynes 25 capsule heated 20,000 h at 1000°C to 0.021 in. in an Inconel 600 capsule heated 10,000 h at 1000°C. Satisfactory performance through 5000 h at 1400°C in vacuum was demonstrated with a tungsten-25 wt % rhenium alloy capsule containing unirradiated cobalt metal. Satisfactory performance through 18,000 h at 1000°C in air was demonstrated with two Hastelloy X and two Haynes 25 capsules containing irradiated cobalt metal. The initial shipment of 349,800 Ci of ^{60}Co for the WANL 30 kW(t) demonstration heat source was made to the encapsulator. The Hastelloy X being used for fuel capsules and pins for the WANL heat source exhibited satisfactory oxidation resistance during 1000-h tests at 1000 and 1125°C. Preoxidation of Hastelloy X did not impede reaction with Nickel 200 during compatibility tests for up to 10,000 h at 1000°C. A thermoelectric generator fueled with ^{60}Co continued to operate satisfactorily with an electrical output of 70 watts. (auth)

17915 (MLM-1431) ^{238}Pu RADIOISOTOPE FUELED LIFE SUPPORT SYSTEM TEST. Johnson, E. W.; Wysong, J. R.; Zielinski, R. E. (Mound Lab., Miamisburg, Ohio). 15 Feb 1967. Contract AT(33-1)-Gen-53. 39p. Dep. NTIS.

The purpose of this investigation was to determine the feasibility of radioisotopes in life support systems. In order to perform this evaluation, radioisotope capsules were designed and fabricated for operation in the vacuum distillation water recovery unit. The design and fabrication of the radioisotope capsules, the experimental tests conducted, the analysis of the reclaimed water, and the post test examination and evaluation of the radioisotope capsules are discussed. (auth)

17916 (ORNL-4750) ORNL ISOTOPIC POWER FUELS QUARTERLY REPORT FOR PERIOD ENDING SEPTEMBER 30, 1971. Lamb, Eugene (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 36p. Dep. NTIS.

Examination of sealed refractory metal-$^{244}Cm_2O_3$ compatibility capsules exposed for 10,000 h at 1250°C revealed no serious interactions except with zirconium. Work continues on the preparation of microparticles for cermet development using loaded ion-exchange beads. Efforts have been directed toward the development of a quick, simple method of achieving 100% loading of the ion-exchange resin. Although each of the three methods tested produced resin loaded to sufficiently high levels, none are entirely satisfactory due to excessive time, complexity, or other factors. A $^{244}Cm_2O_3$ cermet with 80 vol % iridium is comparable in power density to a $^{238}PuO_2$ cermet with 20 vol % iridium. The incremental cost of iridium cermets is small. Cermet fabrication studies with ThO_2 and molybdenum as stand-ins for $^{244}Cm_2O_3$ and noble metals showed that strong, helium-permeable cermets could be made containing up to 60 vol % ThO_2 by hot-pressing. However, with the cold-press-and-sinter technique, 20 vol % ThO_2 was the maximum. Experiments to determine the phases present in mixtures of Cm_2O_3 and PuO_2 containing up to 10 mole % Cm_2O_3 were completed. Fluidization studies were made in the ½-in.-ID coater with a 1-mm orifice and 20° cone. Five-gram batches of ThO_2 particles were used as a stand-in for $^{238}PuO_2$ in the fluid bed coater test runs. Cold-pressing and sintering was used to fabricate $^{238}PuO_2$ and $^{242}Cm-^{238}PuO_2$ pellets. Since the $Cm-PuO_2$ pellets were not acceptable, both the $^{238}PuO_2$ and $^{242}Cm-^{238}PuO_2$ pellets were refabricated by hot-pressing. Partial and total pressures of various vapor species above solid Tm_2O_3 and solid Yb_2O_3 at 1990°C have been determined in small and large Knudsen cells. A Pt-30% Rh-10% W alloy was developed for cladding space isotopic power fuels. Comparing recrystallized materials, this alloy was stronger than the molybdenum alloy TZM at elevated temperatures. Sufficient material is being prepared to evaluate its fabricability and weldability. Tensile tests of 20-mil-thick T-111 doped with oxygen at 1000°C show that a level of 800 ppM oxygen is sufficient to cause complete embrittlement even at test temperatures to 1300°C. Preliminary data suggest that a level of only 400 ppM oxygen will cause complete embrittlement at doping temperatures of 825°C. This lower temperature corresponds to conditions in the Pioneer thermoelectric generators. Heat treatments above 1300°C ductilized T-111 containing up to 4000 ppM oxygen through precipitation of noncoherent HfO_2 particles. Wrapping T-111 with molybdenum foil and using zirconium getters under conditions similar to those in the Pioneer RTG were not effective methods of reducing the rate of contamination; however, thin coatings of molybdenum were. TZM was also found to be embrittled by oxygen, but, due to the lower rate of oxygen diffusion in molybdenum, longer times were required. A total of 35 sets of getter housings was fabricated of palladium for Pioneer RTG's. A wide variety of nonfuel compatibility couples was put on test for 500 h at 1300, 1400, and 1500°C in support of the DART program. (auth)

17917 (SC-RR-710354) HAVE SINEW-1 PREFLIGHT REPORT. Bustamante, A. C.; Randall, D. E.; Deveney, J. E.; Warthen, C. M.; Berst, D. W. (Sandia Labs., Albuquerque, N. Mex.). Jan 1972. 101p. Dep. NTIS.

A preflight description of the HAVE SINEW-1 reentry test flight is presented. The test program is directed toward providing reliable instrumentation and methods of recovering impacted payloads. (J.R.D.)

17918 TIMEPIECE WITH RADIOACTIVE TIMEKEEPING STANDARD. Koehler, Dale R.; Grissom, John T. U. S. Patent 3,629,582. 21 Dec 1971. Filed 24 Apr 1969.

A timepiece with a frequency standard in the form of a long half-life alpha emitter is described. The alpha particulate emana-

tions from the source are converted into electrical pulses which are scaled down to produce low-frequency control pulses at a constant rate. (Official Gazette)

Radiation Sources

Refer also to abstracts 17696 and 17913.

17919 APPLICATION OF RADIOISOTOPE GAMMA AND X-RAY SOURCES IN THE ANALYSIS OF INDUSTRIAL MATERIALS. Dziunikowski, Bohdan (Akademia Gorniczo-Hutnicza, Krakow). Zesz. Nauk. Akad. Gorn.-Hutn., Cracow, Mat. Fiz. Chem.; No. 5, 5-110(1970). (In Polish).

New methods are described for overcoming matrix effects in radioisotope x-ray fluorescence. These methods are based on the use of the same absorption edge filters as required to isolate the secondary x rays of wanted elements excited in material under text. Application of the methods suggested can be useful in eliminating matrix effects due to two or three interfering elements present with variable concentrations. Also, the proper choice of energy as well as activity of radioisotope sources in x-ray fluorescence are discussed. Several analytical problems resolved by means of various radiometric methods, using soft γ or x-ray sources, are described. In particular, determination of iron in iron-bearing sands, zirconium in beach-sands and zinc in lead-zinc ores are considered. General suggestions dealing with usefulness of radiometric nonactivation methods of analysis are presented. (auth) (INIS)

17920 METHOD FOR ELECTROLYTICALLY COATING AN ALUMINIUM SUBSTRATE WITH A STRONTIUM COMPOUND. Barring, Nils-Eric Hyalmar (to Aktiebolaget Atomenergi). British Patent 1,256,544. 8 Dec 1971. Priority date 15 Nov 1968, Sweden.

A method for electrolytically coating an aluminum substrate with a strontium compound comprises arranging the depassivated aluminum substrate as the cathode in an electrolyte containing a strontium salt as solute and a mixture of water and a miscible organic liquid as solvent and applying an electric potential between the cathode and an anode in contact with the electrolyte. The alumnium can be depassivated by conventional methods, but a preferred method is that of subjecting the aluminum to a pre-electrolysis in the mixture of water and miscible organic liquid for a few minutes before the addition of the strontium salt. The method is particularly suitable for the preparation of aluminum substrates coated with ^{90}Sr to produce radiation sources for the radiation treatment of human organisms. (B.L.M.)

Design and Fabrication

Refer also to abstracts 17621 and 17622.

17921 (UCRL-20857) SOURCE OF ALPHA PARTICLES COLLIMATED TO 35 μm. Derenzo, Stephen E.; Anderberg, Dane H.; Buckingham, Sharon O.; Savignano, Joseph A.; Smits, Robert G.; Vuletich, Tony.; Zaklad, Haim; Muller, Richard A. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1971. 6p. Dep. NTIS.

The manufacture of a source of 5.5-MeV alpha particles collimated with gold foil to a width of 35 μm is described. The source width was measured by using nuclear emulsions and by using a multiwire liquid xenon ionization chamber. (auth)

Industrial Uses

Refer also to abstract 17557.

17922 (AED-CONF-71-100-55) RADIOISOTOPES IN MECHANICAL ENGINEERING. Gerve, J. Andreas (Kernforschungszentrum, Karlsruhe (West Germany). Laboratorium fuer Isotopentechnik). May 1971. 25p. (CONF-710901-539). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The use of radioisotopes in mechanical engineering has gained new importance due to advancements in and successful tests of the so-called thin layer activation. The use of thin layer activation with heavy loaded particles is discussed as well as examples of radioisotopes uses in mechanical engineering for simultaneous measurement of thickness and density in thin layers, determination of size and distribution of wear particles, and movement measurements, such as roller speed in a roller bearing. (L.C.L.)

17923 (CPSR-310) INDUSTRIAL APPLICATION OF RADIATION INDUCED GRAFTED COTTON. DasGupta, Sharda (Atomic Energy of Canada Ltd., Ottawa (Ontario). Commercial Products [Div.]). [1971]. 28p. (CONF-710343-1). Dep. NTIS (U. S. Sales Only).

From 161st national meeting of the American Chemical Society; Los Angeles, Calif. (28 Mar 1971).

Optimum conditions for grafting on cotton and its blends and the potential commercial applications of such products are presented. Simultaneous irradiation methods were used for grafting vinyl monomers, such as styrene, acrylonitrile, or as mixtures to rolls of cotton. An AECL Gammacell 220 and a shielded room irradiation facility were used for irradiation. The procedure was found to be simple and suitable for grafting on large rolls. Since polymer, monomer, and solvent (primary alcohol) are irradiated together, all the free radicals generated are consumed as they are formed and no special atmosphere is necessary. The creation of polymeric structures with many desirable properties and the economics of the method are discussed. (P.C.H.)

17924 (NP-19171) CODE OF GOOD MANUFACTURING PRACTICE FOR THERAPEUTIC GOODS. (National Biological Standards Lab., Canberra (Australia)). Aug 1971. 19p. Dep. NTIS (U. S. Sales Only).

Special provisions concerning the technical and administrative procedures to be applied in radiation sterilization of medical supplies and pharmaceuticals are detailed under the headings: sterilizing dose; validation and microbiological control of manufacturing and sterilizing process; radiation facilities; requirements for radiation safety; irradiation process control; irradiation dosimetry; and irradiation records. (Australia)

17925 (ORNL-IIC-11(Rev.)) RADIATION PASTEURIZATION OF FRUITS AND VEGETABLES, A BIBLIOGRAPHY. McKinney, F. E. (ed.) (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 90p. Dep. NTIS.

References to 1264 publications that discuss the radiation processing of fruits and vegetables are presented. References from ORNL-IIC-11; ORNL-IIC-11 Suppl. I; and ORNL-IIC-11 Suppl. II, additional U.S. references, and a compilation of foreign references are included. Author and subject indexes are also included. (C.H.)

17926 FOOD IRRADIATION: PROBLEMS AND PROSPECTS. Faizur Rahman, A. T. M.; Matin, A.; Siddiqui, A. K.; Amin, M. R. (Atomic Energy Centre, Dacca, Pakistan). Nucleus (Karachi); 8: No. 3, 59-76(Jul-Sep 1971).

The paper discusses in some detail the application of irradiation to the preservation of food products, examines the feasibility of the technique with special reference to East Pakistan, and concludes that in the long run food irradiation could confer considerable benefit by reducing spoilage losses. (auth)

17927 DETERMINATION OF CALORIFIC VALUE OF COAL BY MEANS OF RADIOACTIVE ISOTOPES. III. Csom, Gyula (Egyetemi Atomreaktor, Budapest). Energ. Atomtech.; 23: No. 6, 290-6(Jun 1970). (In Hungarian).

Automation of coal-fired power plants requires continuous, accurate measurement of various plant operating characteristics. To achieve this, radiometric methods for continuously measuring the calorific value of the coal used are suggested. A two-channel γ absorption method for determining the composition of the coal ashes, and thereby establishing the calorie content of the coal, is described and compared with other proposed radiometric methods. (L.C.L.)

17928 DETERMINATIOF OF CALORIFIC VALUE OF COAL BY MEANS OF RADIOACTIVE ISOTOPES. II. Csom, G. (Egyetemi Atomreaktor, Budapest). Energ. Atomtech.; 23: No. 3, 133-43(Mar 1970). (In Hungarian).

Automation of coal-fired power plants requires continuous, accurate measurement of various plant operating characteristics. To achieve this, radiometric methods for continuously measuring the calorific value of the coal used are suggested. A γ absorption method for determining the composition of the coal ashes, and thereby establishing the calorie content of the coal, is described and compared with other proposed radiometric methods. (In Hungarian) (L.C.L.)

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17929 JADROVE ZIARENIE V MEDICINE A FARMACII. (Nuclear Radiation in Medicine and Pharmacy). Hupka, Stefan (ed.). Bratislava; Vydavatel'stvo Osveta (1971). 606p.

Applications of nuclear radiations in medical diagnosis and therapy are described in detail. The principles of nuclear physics and radiation detection instruments are reviewed. The preparation of a number of radioisotope-labeled drugs for use in diagnosis, therapy, and metabolic studies on drugs is described. Radiation protection procedures to ensure the safe handling and use of radioisotopes in medical and pharmaceutical facilities are included. (C.H.)

17930 PROBLEMY RADIOBIOLOGII. (Problems of Radiobiology). Kuzin, A. M. Moscow; Izdatel'stvo Znanie (1970). 96p.

Early chapters deal with the general aspects of radiation and life, and the special features of the effects of ionizing radiations on organisms. Successive chapters are devoted to more specific information on radiation damage to the nucleus of a cell, the cytoplasm, and the cell itself. Chemical protection, sensitization, and restoration are discussed, with a list of a dozen organic compounds known to have protective action against ionizing radiation in mammals. Processes of development, differentiation, and self-regulation are considered. The last chapter describes the contribution of radiobiology to agriculture, medicine, and the food industry. (K.S.W.)

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 17335, 17951, and 18056.

17931 EFFECT OF X-RAY IRRADIATION ON GLUTATHIONE PEROXIDASE. Olinescu, Radu (Clinical Hospital Fundeni, Bucharest). Rev. Roum. Biochim.; 8: No. 3, 231-8 (1971).

By using x-irradiation, modifications of the regulatory and catalytic functions of glutathione (GSH) peroxidase were obtained. The regulatory function is more radiosensitive than the catalytic one. Cumene hydroperoxide used as substrate protects both functions. NADPH-induced stimulation of GSH peroxidase activity is lost as a function of the irradiation dose. Presumably, NADPH-induced stimulation of GSH peroxidase activity is due to a methemoglobin contamination. (auth)

17932 EFFECT OF IRRADIATION ON THE BIOSYNTHESIS OF LIVER RIBONUCLEIC ACIDS IN INTACT AND ADRENALECTOMIZED RATS. Popov, P. G.; Valeva-Dimitrova, L. I.; Hadjiolov, A. A. (Biochemical Research Lab., Sofia). Z. Naturforsch., 26b; No. 12, 1282-7(Dec 1971).

Intact and adrenalectomized rats were irradiated with 900 R or treated with 10 mg per 100 g body weight of hydrocortisone. The incorporation of orotic acid-6-^{14}C for 2 hrs into liver free uridine nucleotides, nuclear and cytoplasmic RNA, and RNA fractions obtained by agar gel electrophoresis, were studied. The obtained results show that in intact animals both irradiation and hydrocortisone induce a higher labelling of cytoplasmic and nuclear liver RNA. The higher labelling of RNA is not correlated with a higher labelling of the free uridine nucleotides. The labelling of all electrophoretic RNA fractions is increased to approximately the same extent under the action of either hydrocortisone or irradiation. Irradiation or hydrocortisone treatment of adrenalectomized rats causes also a higher labelling of liver nuclear and cytoplasmic RNA. The higher labelling of RNA is not correlated with that of free uridine nucleotides and affects all electrophoretic RNA fractions. The combined action of irradiation and hydrocortisone shows an additive effect on the labelling of nuclear and cytoplasmic liver RNA. The obtained results indicate that whole-body irradiation causes an increased synthesis of both ribosomal and non-ribosomal RNA's of rat liver. Since the same effect is observed in intact and adrenalectomized animals it may be concluded that the stimulation of liver RNA synthesis by irradiation is not mediated by the adrenals. (auth)

17933 RELEASE OF THE β-GALACTOSIDASE-SYNTHESIZING SYSTEM FROM ULTRAVIOLET CATABOLITE REPRESSION BY CYCLIC 3',5'-ADENOSINE MONOPHOSPHATE, DARK REPAIR, PHOTOREACTIVATION, AND COLD TREATMENT. Swenson, P. A. (Oak Ridge National Lab., Tenn.). J. Bacteriol.; 109: No. 1, 391-8(Jan 1972).

Recovery from the inhibitory effect of ultraviolet irradiation on the induced synthesis of β-galactosidase was studied in Escherichia coli B/r. When irradiated cells (520 ergs/mm^2 at 254 nm) were induced and incubated in minimal medium supplemented with Casamino Acids (conditions of catabolite repression), the ability to form enzyme was greatly reduced for about 100 min and then recovery began. The inhibition observed immediately after ultraviolet irradiation was partially reversed by cyclic 3', 5'-adenosine monophosphate (cyclic AMP) or by photoreactivation treatment. Inhibition was reduced if the cells were given cold treatment (5 C) before or during irradiation; the kinetics of induced enzyme formation in each case were similar to those of irradiated cells receiving cyclic AMP. These kinetics suggest that the cold treatments, like cyclic AMP, cause the release of the β-galactosidase-synthesizing system from catabolite repression. When irradiated cells were incubated for various times before cyclic AMP or photoreactivation treatment, some reversal of the inhibition of induced enzyme formation was obtained, but by 100 min the treatments were ineffective. Because 100 min was also the time at which dark recovery of enzyme formation began, the recovery process was interpreted to be the result of completion of DNA repair, which, in turn, released the β-galactosidase-synthesizing system from catabolite repression. (auth)

17934 FORMATION OF SINGLE-STRAND BREAKS IN INTRACELLULAR DNA BY X-RAYS. Johansen, Ivar (Norwegian Defence Research Establishment, Kjeller); Gurvin, Ingmund; Rupp, W. Dean. Radiat. Res.; 48: No. 3, 599-612(Dec 1971).

The number of x-ray induced DNA single-strand breaks under physiological conditions was determined by measuring production of the first break in closed covalent DNA molecules of bacteriophage λ in immune host bacteria. Under conditions of little repair, the anoxic rate of DNA single-strand breakage is 1.3×10^{-6} DNA single-strand breaks per rad per 10^6 daltons. Under full oxygenation closed covalent DNA is 3.3 times more sensitive to strand breakage, the yield being 4.4×10^{-6} breaks/rad/10^6 daltons. Oxygen-promoted strand breaks formed at ice temperature are repaired almost instantaneously at 38°C, and probably represent a harmless lesion. (auth)

17935 GENE FREQUENCY ANALYSIS OF CHROMOSOMAL INITIATION SITES IN BACILLUS SUBTILIS AFTER ULTRAVIOLET LIGHT OR X-RAY EXPOSURE. Billen, Daniel; Hellerman, Gary; Carreira, Laura (Univ. of Florida, Gainesville). Contract AT(40-1)-3596. J. Bacteriol.; 109: No. 1, 379-84 (Jan 1972).

Bacillus subtilis was exposed to ultraviolet light (uv) or x rays, and gene frequency analysis was used to study the location of initiation sites of postirradiation deoxyribonuclei acid (DNA) synthesis. It was found that DNA synthesis resumes primarily from the origin after uv exposure. With x irradiation, the origin is not selectively replicated. Elevated origin-to-terminal marker ratios observed after uv exposure of exponentially growing cells were interpreted as evidence for selective uv resistance of the replicative origin region of the bacterial chromosome. (auth)

17936 CYTOTOXIC ACTION OF IRRADIATED HISTIDINE ON RAT THYMOCYTES IN VITRO. Ueno, Akiko M. (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol.; 21: No. 1, 43-8(Jan 1972).

The effects of irradiated histidine on the survival of isolated rat thymocytes were studied. Incubation of unirradiated thymocytes with the histidine irradiated with γ rays over a range of 8 to 204 krads in Krebs–Ringer's solution caused an increase in the death-rate of cells, as measured by erythrosin-B staining. Based on comparative studies on cytotoxic abilities with special reference to sulphydryl reactivity between irradiated histidine and N-ethylmaleimide, a sulphydryl reagent, it is suggested that intracellular sulphydryl groups are involved in some mechanism of cell death after treatment of cells with the irradiated histidine. (auth) (UK)

17937 COMPUTER ANALYSIS AND RECONSTRUCTION OF E.S.R. SPECTRA OF GAMMA-IRRADIATED DNA. Gregoli, Silvano; Bertinchamps, Albert (Univ. Libre, Brussels). Int. J. Radiat. Biol.; 21: No. 1, 75-85(Jan 1972).

It was suggested from the results of previous studies that in DNA γ-irradiated in the dry state at 25°C an electronic migration

occurs that transforms the primary random radioproducts into new ones, localized essentially on the pyrimidine nucleotides, dTMP and dCMP. According to this mechanism, the ESR spectrum of irradiated DNA should consist of the weighted superimposition of pyrimidine patterns only. Conversely, starting from pyrimidine patterns only, it should be possible to reconstruct the ESR spectrum of DNA. An attempt was made to isolate the constituent patterns from the dTMP and dCMP experimental spectra. While the dCMP spectrum, C, behaved like a single entity, the spectrum of dTMP was found to consist of the superimposition of three main patterns called τ_1, τ_2 and τ_3. A program was prepared to perform a large number of linear combinations following the formula $\Delta = h_1\tau_1 + h_2\tau_2 + h_3\tau_3 + kC$, where the variable coefficient represented the relative intensity of the four elementary patterns in the resulting spectra Δ. An atlas of reconstructed spectra was obtained all built up from the same pyrimidine patterns, but at different relative intensity. According to the hypothesis, for each experimental spectrum of DNA there should be an identical one among the reconstructed spectra. A series of DNA spectra obtained in the authors' laboratory or published in the literature were successfully subjected to this test. For each of them, the relative yields of the different pyrimidine radicals were determined by comparison. (auth)

17938 MAGNETIC RESONANCE STUDY OF RADICAL RECOMBINATION IN IRRADIATED CYSTEINE HYDROCHLORIDE MONOHYDRATE. Ramsbottom, J. V.; Pintar, M. M.; Forbes, W. F. (Univ. of Waterloo, Ont.). Radiat. Res.; 48: No. 3, 454-73(Dec 1971).

Radical recombination reactions in samples of irradiated cysteine hydrochloride monohydrate are investigated, using electron paramagnetic resonance (EPR) and nuclear magnetic resonance (NMR) spectroscopy. Radicals were induced by ultraviolet light and by γ irradiation. Two phases can be identified in the crystals, and recombination rates of the sulphur radicals were found to be different in the two phases. One phase is believed to represent a glassy phase which shows unusual NMR properties, particularly at 393°K when vigorous motion appeared to average out almost all of the dipolar line width. This phase is not detected in anhydrous cysteine hydrochloride. Possible mechanisms of the recombination reactions are discussed, consistent with the experimentally determined activation energies in the two phases. (auth)

17939 EFFECT OF 5-BROMOURACIL ON ENERGY TRANSFER IN DNA AND RELATED MODEL SYSTEMS. PURINE: PYRIMIDINE CRYSTAL COMPLEXES. Lillicrap, S. C.; Fielden, E. M. (Inst. of Cancer Research, Belmont, Eng.). Radiat. Res.; 48: No. 3, 432-46(Dec 1971).

Hydrogen-bonded cocrystal complexes between adenosine and 5-bromouridine and between 9-methyladenine and 1-methylthymine with various amounts of the 1-methylthymine replaced by 1-methyl-5-bromouracil have been studied as models for the behavior of 5-bromouracil in DNA. The behavior of the excited states formed after ionizing irradiation in these systems has been studied by observing the luminescence parameters over a temperature range from 93°K to 200°K and from 5 μsec to 1 sec after a 1.6 μsec electron pulse. In the two-component crystal complexes there is very efficient transfer of electronic excitation energy to the components with the lowest triplet state. In all the systems studied the "acceptor" molecule is the brominated pyrimidine. In the crystal complexes containing small amounts of 5-bromouracil there is evidence of long range energy transfer over at least 200 base pairs with emission still occurring from the lowest triplet level of the system. The rate of migration of electronic energy at low temperature is calculated as 2×10^4 base pairs/second. The migration rate is dependent on the presence of traps and a free migration rate would be nearer 10^8 base pairs/second. The mechanism of this energy transfer is considered. (auth)

17940 EFFECT OF 5-BROMOURACIL ON ENERGY TRANSFER IN DNA AND RELATED MODEL SYSTEMS: DNA WITH INCORPORATED 5-BUdR. Fielden, E. M.; Lillicrap, S. C.; Robins, A. B. (Inst. of Cancer Research, Belmont, Eng.). Radiat. Res.; 48: No. 3, 421-31(Dec 1971).

The luminescence induced in DNA by a microsecond pulse of radiation has been studied as a function of the percentage incorporation of 5-BUdR. The DNA was extracted from Murine lymphoma cells L5178Y grown in the presence of 5-BUdR. Percentage replacements between 0.03 and 39% were used. The luminescence spectra and kinetics are markedly altered by the presence of the halogenated pyrimidine. Emission from the 5-BUdR moiety is dominant even at low percentage incorporations. The results are explained by an extensive intramolecular migration of charge or excitation energy to the 5-BUdR sites in the DNA. The migration or delocalization distance was calculated to be 100 ± 20 base pairs. The correlation between the observed energy transfer and the radiosensitizing action of 5-BUdR is discussed. (auth)

Radiation Effects on Cultured Cells (External Source)

17941 EFFECTS OF X-IRRADIATION ON TISSUE FORMATIVE ACTIVITY AND SORTING-OUT ACTIVITY OF HeLa CELLS IN ROTATION CULTURE. Kuroda, Y. (National Inst. of Genetics, Misima, Japan). Radiat. Res.; 48: No. 3, 565-77(Dec 1971).

The effects of x-irradiation on the HeLa cells for their histoformative aggregate-forming activity and sorting-out activity of embryonic quail liver cells were investigated. No significant difference was detected in the diameter of aggregates formed from cells irradiated with the wide range of x rays. When non-irradiated control HeLa cells were intermixed with embryonic quail liver cells and allowed to form aggregates in rotation culture, both types of cells became sorted out from each other and formed separate aggregates. HeLa cells which were irradiated with increasing doses of x rays gradually lost the sorting-out activity. To determine the presence of restitution process in the loss of sorting-out activity of HeLa cells, cells were exposed to fractionated x irradiation and allowed to form aggregates. When HeLa cells were exposed to double doses of 1,000 R with a time interval of two hours, a marked restitution was found in their sorting-out activity. (auth)

17942 SURVIVAL CURVES AND DOSE FRACTIONATION: SOME GENERAL CHARACTERISTICS. Dienes, G. J. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 48: No. 3, 551-64(Dec 1971).

The response of a cellular population to fractionated doses of radiation has been investigated analytically based on the general kinetic model of radiation response with the multitarget and multihit models included as special cases. The results of this analysis are: Maximum recovery occurs for equal-dose fractions. This conclusion is valid for the recovery ratio at a given dose as well as for the dose difference at a given survival level. For equal-dose fractions explicit, but rather complicated formulas were obtained for the recovery characteristics as a function of the number of fractions. Simple relations and scaling rules are valid in the exponential region, i.e., if the survival is exponential at high doses and each fractional dose is high enough for each fractional survival to be in the exponential region. The exponential restriction is important and the simple results must be used with caution. The biological limitations of the treatment are pointed out. (auth)

17943 MODIFICATION OF RADIOSENSITIVITY OF EHRLICH ASCITES CARCINOMA CELLS IN VIVO. 2. SENSITIZING ABILITY OF SULFHYDRYL-BINDING AGENTS TO HYPOXIC TUMOR CELLS. Tanaka, Norimoto; Urano, Muneyasu; Saeki, Yuji; Etoh, Tadatoshi (Kyoto Prefectural Univ. of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 10, 6-11(Jan 1971).

The sensitizing ability of two of the sulfhydryl-binding agents, iodoacetamide (IA) and N-ethylmaleimide (NEM), was studied in an animal-tumor system. Ehrlich ascites tumor cells were treated by one of the agents in vivo or in vitro. Cell irradiation was carried out in the presence of one of the agents. Results were assayed by TD_{50} or determination of number of cells to transplant a tumor in half of the inoculated sites. The radiation response of the hypoxic tumor cells was sensitized by both of the agents. Dose modifying factors for in vivo treatment of IA, in vitro treatment of IA and for in vitro treatment of NEM were 1.66, 1.70 and 1.86 respectively. The possible use of the agents in clinical radiotherapy was discussed but more data are needed before they can be used. (auth)

17944 X-RAY SURVIVAL RESPONSE OF THE MOUSE L CELLS. Terasima, Toyozo; Fujiwara, Yoshisada; Yasukawa, Mieko; Tanaka, Sachiko (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 12: No. 2, 61-72(Jun 1971).

By the use of synchronous mouse L cells, survival response to x rays was determined throughout the cell cycle. The pattern of a single dose survival was essentially the same as found for HeLa cells previously, i.e., most sensitive at mitosis and the G1-S transition phase; most resistant at the early G1; and intermediately resistant at the late S phase. The survival parameters, extrapolation number (n), and mean lethal dose (Do) underwent the similar change during the cell cycle. Difference in sensitivity between early G1 and G1-S transition phase was a factor of 3 in terms of n value, roughly 1.4 in Do value. The development of

LIFE SCIENCES

17929 JADROVE ZIARENIE V MEDICINE A FARMACII. (Nuclear Radiation in Medicine and Pharmacy). Hupka, Stefan (ed.). Bratislava; Vydavatel'stvo Osveta (1971). 606p.

Applications of nuclear radiations in medical diagnosis and therapy are described in detail. The principles of nuclear physics and radiation detection instruments are reviewed. The preparation of a number of radioisotope-labeled drugs for use in diagnosis, therapy, and metabolic studies on drugs is described. Radiation protection procedures to ensure the safe handling and use of radioisotopes in medical and pharmaceutical facilities are included. (C.H.)

17930 PROBLEMY RADIOBIOLOGII. (Problems of Radiobiology). Kuzin, A. M. Moscow; Izdatel'stvo Znanie (1970). 96p.

Early chapters deal with the general aspects of radiation and life, and the special features of the effects of ionizing radiations on organisms. Successive chapters are devoted to more specific information on radiation damage to the nucleus of a cell, the cytoplasm, and the cell itself. Chemical protection, sensitization, and restoration are discussed, with a list of a dozen organic compounds known to have protective action against ionizing radiation in mammals. Processes of development, differentiation, and self-regulation are considered. The last chapter describes the contribution of radiobiology to agriculture, medicine, and the food industry. (K.S.W.)

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 17335, 17951, and 18056.

17931 EFFECT OF X-RAY IRRADIATION ON GLUTATHIONE PEROXIDASE. Olinescu, Radu (Clinical Hospital Fundeni, Bucharest). Rev. Roum. Biochim.; 8: No. 3, 231-8 (1971).

By using x-irradiation, modifications of the regulatory and catalytic functions of glutathione (GSH) peroxidase were obtained. The regulatory function is more radiosensitive than the catalytic one. Cumene hydroperoxide used as substrate protects both functions. NADPH-induced stimulation of GSH peroxidase activity is lost as a function of the irradiation dose. Presumably, NADPH-induced stimulation of GSH peroxidase activity is due to a methemoglobin contamination. (auth)

17932 EFFECT OF IRRADIATION ON THE BIOSYNTHESIS OF LIVER RIBONUCLEIC ACIDS IN INTACT AND ADRENALECTOMIZED RATS. Popov, P. G.; Valeva-Dimitrova, L. I.; Hadjiolov, A. A. (Biochemical Research Lab., Sofia). Z. Naturforsch., 26b; No. 12, 1282-7(Dec 1971).

Intact and adrenalectomized rats were irradiated with 900 R or treated with 10 mg per 100 g body weight of hydrocortisone. The incorporation of orotic acid-6-^{14}C for 2 hrs into liver free uridine nucleotides, nuclear and cytoplasmic RNA, and RNA fractions obtained by agar gel electrophoresis, were studied. The obtained results show that in intact animals both irradiation and hydrocortisone induce a higher labelling of cytoplasmic and nuclear liver RNA. The higher labelling of RNA is not correlated with a higher labelling of the free uridine nucleotides. The labelling of all electrophoretic RNA fractions is increased to approximately the same extent under the action of either hydrocortisone or irradiation. Irradiation or hydrocortisone treatment of adrenalectomized rats causes also a higher labelling of liver nuclear and cytoplasmic RNA. The higher labelling of RNA is not correlated with that of free uridine nucleotides and affects all electrophoretic RNA fractions. The combined action of irradiation and hydrocortisone shows an additive effect on the labelling of nuclear and cytoplasmic liver RNA. The obtained results indicate that whole-body irradiation causes an increased synthesis of both ribosomal and non-ribosomal RNA's of rat liver. Since the same effect is observed in intact and adrenalectomized animals it may be concluded that the stimulation of liver RNA synthesis by irradiation is not mediated by the adrenals. (auth)

17933 RELEASE OF THE β-GALACTOSIDASE-SYNTHESIZING SYSTEM FROM ULTRAVIOLET CATABOLITE REPRESSION BY CYCLIC 3',5'-ADENOSINE MONOPHOSPHATE, DARK REPAIR, PHOTOREACTIVATION, AND COLD TREATMENT. Swenson, P. A. (Oak Ridge National Lab., Tenn.). J. Bacteriol.; 109: No. 1, 391-8(Jan 1972).

Recovery from the inhibitory effect of ultraviolet irradiation on the induced synthesis of β-galactosidase was studied in Escherichia coli B/r. When irradiated cells (520 ergs/mm^2 at 254 nm) were induced and incubated in minimal medium supplemented with Casamino Acids (conditions of catabolite repression), the ability to form enzyme was greatly reduced for about 100 min and then recovery began. The inhibition observed immediately after ultraviolet irradiation was partially reversed by cyclic 3', 5'-adenosine monophosphate (cyclic AMP) or by photoreactivation treatment. Inhibition was reduced if the cells were given cold treatment (5 C) before or during irradiation; the kinetics of induced enzyme formation in each case were similar to those of irradiated cells receiving cyclic AMP. These kinetics suggest that the cold treatments, like cyclic AMP, cause the release of the β-galactosidase-synthesizing system from catabolite repression. When irradiated cells were incubated for various times before cyclic AMP or photoreactivation treatment, some reversal of the inhibition of induced enzyme formation was obtained, but by 100 min the treatments were ineffective. Because 100 min was also the time at which dark recovery of enzyme formation began, the recovery process was interpreted to be the result of completion of DNA repair, which, in turn, released the β-galactosidase-synthesizing system from catabolite repression. (auth)

17934 FORMATION OF SINGLE-STRAND BREAKS IN INTRACELLULAR DNA BY X-RAYS. Johansen, Ivar (Norwegian Defence Research Establishment, Kjeller); Gurvin, Ingmund; Rupp, W. Dean. Radiat. Res.; 48: No. 3, 599-612(Dec 1971).

The number of x-ray induced DNA single-strand breaks under physiological conditions was determined by measuring production of the first break in closed covalent DNA molecules of bacteriophage λ in immune host bacteria. Under conditions of little repair, the anoxic rate of DNA single-strand breakage is 1.3×10^{-6} DNA single-strand breaks per rad per 10^6 daltons. Under full oxygenation closed covalent DNA is 3.3 times more sensitive to strand breakage, the yield being 4.4×10^{-6} breaks/rad/10^6 daltons. Oxygen-promoted strand breaks formed at ice temperature are repaired almost instantaneously at 38°C, and probably represent a harmless lesion. (auth)

17935 GENE FREQUENCY ANALYSIS OF CHROMOSOMAL INITIATION SITES IN BACILLUS SUBTILIS AFTER ULTRAVIOLET LIGHT OR X-RAY EXPOSURE. Billen, Daniel; Hellerman, Gary; Carreira, Laura (Univ. of Florida, Gainesville). Contract AT(40-1)-3596. J. Bacteriol.; 109: No. 1, 379-84 (Jan 1972).

Bacillus subtilis was exposed to ultraviolet light (uv) or x rays, and gene frequency analysis was used to study the location of initiation sites of postirradiation deoxyribonuclei acid (DNA) synthesis. It was found that DNA synthesis resumes primarily from the origin after uv exposure. With x irradiation, the origin is not selectively replicated. Elevated origin-to-terminal marker ratios observed after uv exposure of exponentially growing cells were interpreted as evidence for selective uv resistance of the replicative origin region of the bacterial chromosome. (auth)

17936 CYTOTOXIC ACTION OF IRRADIATED HISTIDINE ON RAT THYMOCYTES IN VITRO. Ueno, Akiko M. (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol.; 21: No. 1, 43-8(Jan 1972).

The effects of irradiated histidine on the survival of isolated rat thymocytes were studied. Incubation of unirradiated thymocytes with the histidine irradiated with γ rays over a range of 8 to 204 krads in Krebs–Ringer's solution caused an increase in the death-rate of cells, as measured by erythrosin-B staining. Based on comparative studies on cytotoxic abilities with special reference to sulphydryl reactivity between irradiated histidine and N-ethylmaleimide, a sulphydryl reagent, it is suggested that intracellular sulphydryl groups are involved in some mechanism of cell death after treatment of cells with the irradiated histidine. (auth) (UK)

17937 COMPUTER ANALYSIS AND RECONSTRUCTION OF E.S.R. SPECTRA OF GAMMA-IRRADIATED DNA. Gregoli, Silvano; Bertinchamps, Albert (Univ. Libre, Brussels). Int. J. Radiat. Biol.; 21: No. 1, 75-85(Jan 1972).

It was suggested from the results of previous studies that in DNA γ-irradiated in the dry state at 25°C an electronic migration

occurs that transforms the primary random radioproducts into new ones, localized essentially on the pyrimidine nucleotides, dTMP and dCMP. According to this mechanism, the ESR spectrum of irradiated DNA should consist of the weighted superimposition of pyrimidine patterns only. Conversely, starting from pyrimidine patterns only, it should be possible to reconstruct the ESR spectrum of DNA. An attempt was made to isolate the constituent patterns from the dTMP and dCMP experimental spectra. While the dCMP spectrum, C, behaved like a single entity, the spectrum of dTMP was found to consist of the superimposition of three main patterns called τ_1, τ_2 and τ_3. A program was prepared to perform a large number of linear combinations following the formula $\Delta = h_1\tau_1 + h_2\tau_2 + h_3\tau_3 + kC$, where the variable coefficient represented the relative intensity of the four elementary patterns in the resulting spectra Δ. An atlas of reconstructed spectra was obtained all built up from the same pyrimidine patterns, but at different relative intensity. According to the hypothesis, for each experimental spectrum of DNA there should be an identical one among the reconstructed spectra. A series of DNA spectra obtained in the authors' laboratory or published in the literature were successfully subjected to this test. For each of them, the relative yields of the different pyrimidine radicals were determined by comparison. (auth)

17938 MAGNETIC RESONANCE STUDY OF RADICAL RECOMBINATION IN IRRADIATED CYSTEINE HYDROCHLORIDE MONOHYDRATE. Ramsbottom, J. V.; Pintar, M. M.; Forbes, W. F. (Univ. of Waterloo, Ont.). Radiat. Res.; 48: No. 3, 454-73(Dec 1971).

Radical recombination reactions in samples of irradiated cysteine hydrochloride monohydrate are investigated, using electron paramagnetic resonance (EPR) and nuclear magnetic resonance (NMR) spectroscopy. Radicals were induced by ultraviolet light and by γ irradiation. Two phases can be identified in the crystals, and recombination rates of the sulphur radicals were found to be different in the two phases. One phase is believed to represent a glassy phase which shows unusual NMR properties, particularly at 393°K when vigorous motion appeared to average out almost all of the dipolar line width. This phase is not detected in anhydrous cysteine hydrochloride. Possible mechanisms of the recombination reactions are discussed, consistent with the experimentally determined activation energies in the two phases. (auth)

17939 EFFECT OF 5-BROMOURACIL ON ENERGY TRANSFER IN DNA AND RELATED MODEL SYSTEMS. PURINE: PYRIMIDINE CRYSTAL COMPLEXES. Lillicrap, S. C.; Fielden, E. M. (Inst. of Cancer Research, Belmont, Eng.). Radiat. Res.; 48: No. 3, 432-46(Dec 1971).

Hydrogen-bonded cocrystal complexes between adenosine and 5-bromouridine and between 9-methyladenine and 1-methylthymine with various amounts of the 1-methylthymine replaced by 1-methyl-5-bromouracil have been studied as models for the behavior of 5-bromouracil in DNA. The behavior of the excited states formed after ionizing irradiation in these systems has been studied by observing the luminescence parameters over a temperature range from 93°K to 200°K and from 5 μsec to 1 sec after a 1.6 μsec electron pulse. In the two-component crystal complexes there is very efficient transfer of electronic excitation energy to the components with the lowest triplet state. In all the systems studied the "acceptor" molecule is the brominated pyrimidine. In the crystal complexes containing small amounts of 5-bromouracil there is evidence of long range energy transfer over at least 200 base pairs with emission still occurring from the lowest triplet level of the system. The rate of migration of electronic energy at low temperature is calculated as 2×10^4 base pairs/second. The migration rate is dependent on the presence of traps and a free migration rate would be nearer 10^8 base pairs/second. The mechanism of this energy transfer is considered. (auth)

17940 EFFECT OF 5-BROMOURACIL ON ENERGY TRANSFER IN DNA AND RELATED MODEL SYSTEMS: DNA WITH INCORPORATED 5-BUdR. Fielden, E. M.; Lillicrap, S. C.; Robins, A. B. (Inst. of Cancer Research, Belmont, Eng.). Radiat. Res.; 48: No. 3, 421-31(Dec 1971).

The luminescence induced in DNA by a microsecond pulse of radiation has been studied as a function of the percentage incorporation of 5-BUdR. The DNA was extracted from Murine lymphoma cells L5178Y grown in the presence of 5-BUdR. Percentage replacements between 0.03 and 39% were used. The luminescence spectra and kinetics are markedly altered by the presence of the halogenated pyrimidine. Emission from the 5-BUdR moiety is dominant even at low percentage incorporations. The results are explained by an extensive intramolecular migration of charge or excitation energy to the 5-BUdR sites in the DNA. The migration or delocalization distance was calculated to be 100 ± 20 base pairs. The correlation between the observed energy transfer and the radiosensitizing action of 5-BUdR is discussed. (auth)

Radiation Effects on Cultured Cells (External Source)

17941 EFFECTS OF X-IRRADIATION ON TISSUE FORMATIVE ACTIVITY AND SORTING-OUT ACTIVITY OF HeLa CELLS IN ROTATION CULTURE. Kuroda, Y. (National Inst. of Genetics, Misima, Japan). Radiat. Res.; 48: No. 3, 565-77(Dec 1971).

The effects of x-irradiation on the HeLa cells for their histoformative aggregate-forming activity and sorting-out activity of embryonic quail liver cells were investigated. No significant difference was detected in the diameter of aggregates formed from cells irradiated with the wide range of x rays. When non-irradiated control HeLa cells were intermixed with embryonic quail liver cells and allowed to form aggregates in rotation culture, both types of cells became sorted out from each other and formed separate aggregates. HeLa cells which were irradiated with increasing doses of x rays gradually lost the sorting-out activity. To determine the presence of restitution process in the loss of sorting-out activity of HeLa cells, cells were exposed to fractionated x irradiation and allowed to form aggregates. When HeLa cells were exposed to double doses of 1,000 R with a time interval of two hours, a marked restitution was found in their sorting-out activity. (auth)

17942 SURVIVAL CURVES AND DOSE FRACTIONATION: SOME GENERAL CHARACTERISTICS. Dienes, G. J. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 48: No. 3, 551-64(Dec 1971).

The response of a cellular population to fractionated doses of radiation has been investigated analytically based on the general kinetic model of radiation response with the multitarget and multihit models included as special cases. The results of this analysis are: Maximum recovery occurs for equal-dose fractions. This conclusion is valid for the recovery ratio at a given dose as well as for the dose difference at a given survival level. For equal-dose fractions explicit, but rather complicated formulas were obtained for the recovery characteristics as a function of the number of fractions. Simple relations and scaling rules are valid in the exponential region, i.e., if the survival is exponential at high doses and each fractional dose is high enough for each fractional survival to be in the exponential region. The exponential restriction is important and the simple results must be used with caution. The biological limitations of the treatment are pointed out. (auth)

17943 MODIFICATION OF RADIOSENSITIVITY OF EHRLICH ASCITES CARCINOMA CELLS IN VIVO. 2. SENSITIZING ABILITY OF SULFHYDRYL-BINDING AGENTS TO HYPOXIC TUMOR CELLS. Tanaka, Norimoto; Urano, Muneyasu; Saeki, Yuji; Etoh, Tadatoshi (Kyoto Prefectural Univ. of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 10, 6-11(Jan 1971).

The sensitizing ability of two of the sulfhydryl-binding agents, iodoacetamide (IA) and N-ethylmaleimide (NEM), was studied in an animal-tumor system. Ehrlich ascites tumor cells were treated by one of the agents in vivo or in vitro. Cell irradiation was carried out in the presence of one of the agents. Results were assayed by TD_{50} or determination of number of cells to transplant a tumor in half of the inoculated sites. The radiation response of the hypoxic tumor cells was sensitized by both of the agents. Dose modifying factors for in vivo treatment of IA, in vitro treatment of IA and for in vitro treatment of NEM were 1.66, 1.70 and 1.86 respectively. The possible use of the agents in clinical radiotherapy was discussed but more data are needed before they can be used. (auth)

17944 X-RAY SURVIVAL RESPONSE OF THE MOUSE L CELLS. Terasima, Toyozo; Fujiwara, Yoshisada; Yasukawa, Mieko; Tanaka, Sachiko (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 12: No. 2, 61-72(Jun 1971).

By the use of synchronous mouse L cells, survival response to x rays was determined throughout the cell cycle. The pattern of a single dose survival was essentially the same as found for HeLa cells previously, i.e., most sensitive at mitosis and the G1-S transition phase; most resistant at the early G1; and intermediately resistant at the late S phase. The survival parameters, extrapolation number (n), and mean lethal dose (Do) underwent the similar change during the cell cycle. Difference in sensitivity between early G1 and G1-S transition phase was a factor of 3 in terms of n value, roughly 1.4 in Do value. The development of

resistance during the S phase was suppressed, although not entirely, by the introduction of hydroxyurea, an inhibitor of DNA synthesis. The finding suggests that the sensitivity during the S phase is strongly related to the DNA synthesis. The survival curve of L cells, either randomly or synchronously growing, exhibited an increasing curvature with radiation dose. However, the frequent renewals of growth medium improved only survivals to more than 900 rads. Several possibilities for such anomalous inactivation were discussed on the basis of medium renewal experiments. (auth)

17945 ABERRANT RECOVERY OF PROTEIN SYNTHESIS AFTER MASSIVE IRRADIATION OF ARACHIS HYPOGAEA, L. CELLS IN VITRO. Verma, D. P. S.; van Huystee, R. B. (Univ. of Western Ontario, London). Radiat. Res.; 48: No. 3, 531-41 (Dec 1971).

Protein synthesis and respiration of 3 day old V-56R peanut (Arachis hypogaea, L.) cell-suspension cultures are reduced to 45 to 55% of controls immediately after a massive dose (500 Krad) of radiation. However, they apparently recovered during 3 to 4 days of postirradiation period. Recovery in protein synthesis and respiration continued and exceeded the control levels one week after radiation. Analysis of the proteins synthesized during the postirradiation period indicated that the distribution of radioactivity in labeled proteins is changed and large molecular weight proteins are directly or indirectly broken down to low molecular weight fractions. A significant increase in endogenous free amino acids is observed during the postirradiation period. Both respiration and protein synthesis started to decline 2 weeks after irradiation and levelled well below the controls during subsequent postirradiation period. Although quantitatively protein synthesis showed an apparent recovery after massive irradiation, the proteins synthesized during postirradiation period are markedly different from normal proteins synthesized in unirradiated cells. Induction of such errors in protein metabolism after irradiation may result in giant cell formation, abnormal growth and subsequent death of the cells. This type of recovery may then be categorized as aberrant recovery after irradiation. (auth)

17946 INDUCTION OF GIANT CELLS IN SUSPENSION CULTURES OF ARACHIS HYPOGAEA, L. BY MASSIVE IRRADIATION. Verma, D. P. S.; van Huystee, R. B. (Univ. of Western Ontario, London). Radiat. Res.; 48: No. 3, 518-30(Dec 1971).

The growth of V-56R peanut (Arachis hypogaea, L.) cell-suspension cultures was inhibited as a function of dose (5-500 krad) of radiation, however, protein synthesis showed an immediate response only after a dose of more than 50 krad. Morphological observations made on the irradiated cells indicated that while cell division is completely arrested after a dose of 50-500 krad, cell expansion seems to be least affected and 50-60% cells become large filamentous giant cells. The frequency of giant cells increased during postirradiation period of 4-5 weeks. Radiation-induced giant cells showed an active cyclosis, denser cytoplasm and higher number of starch grains. Protein synthesis continued even after a massive dose (500 krad) of radiation at approximately 45-55% of controls, if the cells were incubated in fresh medium after irradiation, and showed an apparent recovery during post-irradiation period. The effect of radiation on protein synthesis was also dependent on the age of the cultures and presence of conditioned medium during irradiation. Radiation did not affect the uptake of leucine; however, when the cells were incubated in the same medium after irradiation, the uptake of leucine was decreased about 25% of controls. Irradiated medium also had a pronounced effect on growth, protein synthesis and subsequent recovery after irradiation. (auth)

Radiation Effects on Microorganisms (External Source)

Refer also to abstract 17933.

17947 (AED-C-5-10) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 5. RADIATION EFFECTS ON FOOD. Beising, Kurt (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct 1971. 102p. Dep. NTIS (U. S. Sales Only).

Various aspects of radiation processing of food are included in the 491 references. The bibliography contains references to conferences, dissertations, patents, reports, periodical literature, and books. Author and subject indexes are included. (H.L.W.)

17948 EFFECTS OF MYCOPLASMA CONTAMINATION ON THE RADIOSENSITIVITY OF RAT GLIAL CELLS. Pageau, R. (Massachusetts General Hospital, Boston). Experientia; 27: No. 11, 1328-9(15 Nov 1971).

A line of glial cells from a brain tumor in rats was established; some cultures were accidentally infected with Mycoplasma laidlawii. Graphs are presented to show survival curves of x-irradiated glial cells contaminated with Mycoplasma and those of uncontaminated cells. No significant difference was found between the radiosensitivities of contaminated and healthy cells. The data are discussed with regard to the results of other investigators. (H.L.W.)

17949 IODINATION OF MICROCOCCUS RADIODURANS AND INACTIVATION OF THE REPAIR SYSTEM. Singh, B. B.; Shenoy, M. A.; Gopal Ayengar, A. R. (Bhabha Atomic Research Centre, Bombay). Indian J. Exp. Biol.; 9: No. 4, 518-19(Oct 1971).

Micrococcus radiodurans cells were sensitized to gamma-rays when iodoacetic acid or sodium iodide was present during irradiation. Chemical iodination of cells using Fenton's reagent resulted in exponential dose survival curves for uv as well as gamma-rays. Iodination thus inhibits the post irradiation repair system in this organism. (auth)

17950 COMPETENCE MUTANTS. III. RESPONSES TO RADIATIONS. Postel, Edith Horn; Goodgal, Sol H. (Univ. of Pennsylvania, Philadelphia). J. Bacteriol.; 109: No. 1, 298-306(Jan 1972).

Class 3 com mutants [normal in deoxyribonucleic acid (DNA) uptake but poor in ability to transform] of Hemophilus influenzae were investigated with regard to ultraviolet (uv) and x-ray sensitivity of colony-forming ability and with regard to their ability to be transformed by uv- and x-ray-irradiated DNA. Three mutants, com 40, 60, and 78, were highly uv-sensitive in colony-forming ability. None of the mutants was more sensitive than wild type to uv-irradiated transforming DNA; in fact, six of the mutants showed considerably greater resistance. Two of the mutants (com 40 and 60) were slightly more sensitive to x ray in colony formation, whereas most of the mutants showed some degree of sensitivity to x-ray-irradiated transforming DNA. In addition, the physical fate of x-ray-irradiated transforming DNA has been examined, and in one case (com 48) there was a significant drop in sedimentation value of x-ray-irradiated donor DNA after uptake by recipient cells. The com mutants analyzed have been classified on the basis of their uv and x-ray sensitivities, and, where appropriate, possible biochemical lesions have been implicated. (auth)

17951 EFFECT OF GLUCOSE STARVATION ON THE MELTING POINTS OF DNA FOLLOWING UV IRRADIATION OF ESCHERICHIA COLI 15 $T^-U^-HIS^-$. Slezarikova, V.; Sedliakova, M. (Cancer Research Inst., Bratislava). Folia Microbiol. (Prague); 16: No. 6, 454-6(1971).

The effect of glucose starvation during the pre-irradiation period on the uv resistance and on the DNA melting points was investigated. The radioresistance of Escherichia coli 15 $T^-U^-his^-$ increased markedly with the length of starvation. The DNA melting point of an exponentially growing culture was decreased by a dose of 500 erg/mm^2 by 3°C. The same dose did not affect the melting point of DNA in a prestarved culture. (auth)

17952 CUMULATIVE EFFECT OF GAMMA IRRADIATION ON THE MICROBIAL SOIL POPULATION AND ITS ACTIVITY. Monib, M.; Salam, M. A. A.; El-Hadidy, T. T. (Univ., Cairo. Desert Inst., Mataria, United Arab Republic). Folia Microbiol. (Prague); 16: No. 6, 457-64(1971).

The counts of Azotobacter, N-fixing clostridia, aerobic cellulose decomposing bacteria, spore formers, and actinomycetes were not affected by examined irradiation doses. There were, however, indications of a disturbance in the balance between organisms as evidenced by the rapid increase of actinomycetes and sporeformers during incubation. The effects of various irradiation doses on organic matter decomposition, N-fixing capacity, and nitrification power were negligible. (auth)

17953 RESEARCH IN HUNGARY ON RADIATION PROTECTION DURING EXTENDED SPACE TRIPS. Varteresz, Vilmos. Fiz. Szemle; 21: No. 9-10, 306-9(Sep-Oct 1971). (In Hungarian).

Results are reported from studies on space biology that can be carried out on the earth and the results of which are expected to be of interest not only for space but also for terrestrial applications. It was found that the lethal effect of low dose and dose rate radiation on microorganisms is much lower than that of high-

intensity acute radiation; no differences were found in the mutagenic effects. The results of studies on the formation of interferons which play an important role in protection against viral infections indicated that fractionated irradiation does not reduce interferon formation in mice infected with Newcastle disease virus. Experiments were also carried out on the immunological adaptation of dogs exposed to chronic γ radiation levels. (TTT)

17954 LOSS OF ADSORPTION AND INJECTION ABILITIES IN γ-IRRADIATED PHAGE T1. Coquerelle, Therese; Hagen, Ulrich (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 21: No. 1, 31-41(Jan 1972).

Gamma-irradiation of phage T1, suspended in 0.1 M histidine, inactivated some capacities of phage and blocked the early steps of infection. Five % of the inactivated phages had lesions in the protein coat, either in the head and leading to rupture and release of DNA, or in the tail and affecting adsorption. The host-killing ability was destroyed in 38% of the inactivated phages. The amount of phage DNA injected into the host cell (Escherichia coli) was measured and compared with the loss of plaque-forming ability after γ-irradiation. The chance of the genome becoming injected per lethal hit decreased to 31%. The amount of injected DNA was of the same order as the fraction of phages remaining without double-strand lesions in the DNA, i.e., without double-strand breaks or cross-links. It was suggested that this agreement showed that only the DNA molecules with intact double strands were injected: a view confirmed by the localization of the major part of double breaks in the non-injected DNA. A partial injection of the damaged phage genome seemed less probable for phage T1. (auth) (UK)

17955 INVESTIGATING THE RADIATION RESISTANCE OF YEASTS IN SOLUTIONS OF HIGH CARBOHYDRATE CONCENTRATION. Kiss, Istvan; Farkas, Josef (Koezponti Elelmiszeripari Kutato Intezet, Budapest). Elelmiszertudomany; 3: 93-100(1969). (In Hungarian).

Yeast strains were isolated from natural and cryoconcentrated apple juice and treated with ionizing radiation. The osmophilic character of the pure cultures, the survival curves of the radiation treated yeasts as well as the "D" values were determined. It was established that some of the isolated strains had D values (90-120 krad) that approximated the D value of bacterial spores. The inhibitory threshold concentration of fructose for some of these yeast strains was found to be between 43 and 64%. The spoilage percentage as a function of fructose concentration, water activity and dose level was also studied. In general it was found that the physiological activity and growth of yeast decreased with decreasing water activity. As regards the combined effect of water activity of the nutrient and radiation treatment it was established that the growth of the yeast strains investigated decreased with the increase of fructose concentration and dose level. Of the osmophilic yeasts, the growth optimum of Zygosaccharomyces nadsonii (P 1077/8/1) was found to be about 30% fructose concentration. It seems, that at this concentration fructose provides some protection to the yeast. (auth)

17956 DIGESTIBILITY OF RAT AND MOUSE SELECTIVE DIETS FOLLOWING STERILIZATION BY GAMMA IRRADIATION OR BY STEAM IN CONVENTIONAL RATS. Schoen, A.; Hiller, H. H. (Freie Univ., Berlin). Z. Tierphysiol., Tierernachr. Futtermittelk.; 27: 338-43(Jun 1971). (In German).

The digestibility in the rat of the crude protein, crude fat, and nitrogen-free extract components of a diet, Altromin VM 1225, was investigated. The rats used were of the Sprague-Dawley strain. The diet provided was either unsterilized, steam-sterilized, or sterilized by gamma irradiation with 2.5, 5.0 or 10.0 MRad doses. The digestibility of the variously treated diets was compared inter se. It was found that sterilization with gamma irradiation had an advantageous effect on digestibility. (auth)

17957 SOVREMENNYE PROBLEMY RADIATSIONNOI GENETIKI. (Contemporary Problems in Radiation Genetics). Dubinin, N. P. (ed.). Moscow; Atomizdat (1969). 352p.

The more important trends and lines of research on the genetic consequences of radiation are considered, from bacteriophages to man. The mechanism of radiation damage to chromosomes and their restoration, types of genetic damage, the relative genetic effectiveness of neutrons and of charged particles of high and low energy, and the effects on sexual and somatic cells are separate chapter topics. Radiation-induced cancer, biological models, and differentiated cells are discussed. Later chapters treat the subjects of genetic control of radiosensitivity in bacteria, radiation genetics of fungi and algae, radiosensitivity of plants, and genetic effects of cosmic radiation. (K.S.W.)

17958 ADENINELESS MUTANTS OF RHODOTORULA GRACILIS YEAST AND ITS FAT-FORMING ABILITY. Kvasnikov, E. I.; Poddubnyi, F. N.; Svishchuk, A. A.; (and others) (Inst. of Microbiology and Virology, Moscow. Inst. of Organic Chemistry, Kiev). Tsitol. Genet.; 5: No. 2, 112-15(Mar-Apr 1971). (In Russian).

Under the effect of ultraviolet luminescence, six adenine-dependent mutants of Rh. gracilis yeast were obtained. A dose of 4000 erg/mm^2 proved to be an optimal one of uv rays for appearance of mutants (0.055 ± 0.45%). The mutants needing adenine are characterized by a lowered ability for synthetizing lipids. So, if the control strain formed 52.4% of lipids, the adenine mutants contained only 10.4 to 24.4% of them. (auth)

17959 CHLORAMPHENICOL RESCUE OF γ-IRRADIATED lon AND exrA MUTANTS OF ESCHERICHIA COLI. Marshall, N. J.; Gillies, N. E. (Middlesex Hospital Medical School, London). Mutat. Res.; 14: No. 1, 13-21(Jan 1972).

The effect of post-irradiation chloramphenicol treatment (PCT) on a number of radiation-sensitive mutants of Escherichia coli B and Escherichia coli K_{12} was investigated. The two unsuppressed lon mutants and all four exrA mutants examined were rescued by PCT. The lon strains that filamented extensively after irradiation and showed a higher survival when grown in the presence of pantoyl lactone, were probably rescued by PCT as a consequence of suppression of filament formation; the recovery process acting in the exrA mutants is not known. Survival of recA, recB, or pol mutants was little affected, while both exrA strains mutated at sul suffered further killing. (auth)

17960 SYNERGISTIC EFFECT OF AN ESCHERICHIA COLI MUTATOR GENE ON MUTAGENESIS BY ULTRAVIOLET RADIATION AND BY ALKYLATING AGENTS. Hill, Ruth F. (York Univ., Toronto). Mutat. Res.; 14: No. 1, 23-31(Jan 1972).

E. coli strains differing in a gene responsible for high spontaneous mutability (mut HI) were compared for their mutability by uv radiation and by the alkylating agents ethyl methanesulfonate and methyl methanesulfonate. All three exogenous mutagenic agents induced significantly higher frequencies of mutants with impaired carbohydrate-fermenting ability when the mutator allele rather than the wild-type allele was present. Thus the mut HI gene product possibly increases the probability of replication error due to alterations in the structure of the template strand of DNA. An attempt to detect a synergistic effect for uv-induced suppressor mutations was unsuccessful. The failure may have been due to the particular method used for scoring this type of mutation. (auth)

17961 FURTHER CYTOLOGICAL STUDIES ON G_1 X-RAYED PRIMARY ROOTS OF VICIA FABA: CHROMOSOME ABERRATIONS, MITOTIC FREQUENCY, AND MULTIPLE FIXATION. Miller, Morton W.; Colaiace, Joyce D. (Univ. of Rochester, N. Y.). Mutat. Res.; 14: No. 1, 33-41(Jan 1972). (UR-49-1418).

Soaked seeds of Vicia faba were irradiated with 800 or 400 R, or two 400-R exposures separated by 2 hr. Samples from each exposure showed that the chromosome aberration yields varied with fixation time; the source of the variation was due to the inherent properties of the mitotic cell populations and not to a contamination of first mitotics with second and third mitotics for the exposure regimen. The results indicate that an experiment with but a single fixation time would obviously lead to incorrect estimates of chromosome damage because comparable cells in differently treated specimens may not be in mitosis concurrently; for example, a resistant subpopulation of cells may arrive in mitosis at different fixation intervals with different exposures. (auth)

17962 INFLUENCE OF THE SEX CHROMOSOMES ON THE RADIOSENSITIVITY OF DIFFERENT CELL TYPES OF DROSOPHILA MELANOGASTER. Leuthold, Urs (Eidgenoessische Technische Hochschule, Zurich). Mutat. Res.; 14: No. 1, 65-81 (Jan 1972). (In German).

In Drosophila melanogaster, individuals with surplus chromosomes can be produced by the crossing of adequate genotypes. The influence of such additional chromosomes on the induction of dominant lethals was examined with x rays. Since stocks with compound sex chromosomes are available and easy to handle we used the variation of the number of sex chromosomes as a model system. Gametes and zygotes were irradiated with different radiation doses. Mature sperm were irradiated in (1) X/Y males having respectively X and Y sperm with the same amount of chromosomes, and (2) XY/O males with sperm of different amounts of chromosomes (XY and nullo-Y sperm, respectively). Mature eggs (stage-14 oocytes) were irradiated in (3) X/X fe-

males whose deposited eggs form after meiosis only one type of maternal pronuclei (X pronucleus), and in (4) XX/O females whose eggs contain maternal pronuclei of different amounts of chromosomes (XX and nullo-X pronuclei, respectively). The following couples of zygote types were examined in separate experiments: (5) X/X and X/Y, (6) XX/O and XY/O, as well as (7) XY/XY and XY/O. The genotype of the respective irradiated cells could be determined by the phenotype of the surviving imagines. There exists a positive correlation between the number of irradiated chromosomes and the radiosensitivity regarding the induction of dominant lethals. The highest sensitivity per haploid chromosome set is evident in stage-14 oocytes; it is about five times less in mature sperm and zygotes. The dominant lethals were recorded separately according to early, late, and postembryonic lethality. The relative frequency of these three types changes after the irradiation of eggs, sperm, and zygotes. The results show that the mortality after irradiation is due to x-ray-induced chromosome damage, i.e. that it depends on real dominant lethals. (auth)

17963 PROTEIN AND RNA SYNTHESIS IN RADIATION-SENSITIVE STRAINS OF YEAST. Myers, D. K. (Chalk River Nuclear Labs., Ont.). Mutat. Res.; 14: No. 1, 112-14(Jan 1972).

Radiation sensitive mutants were isolated from a variety of microorganisms including yeast. These strains are more sensitive to the lethal effect of ultraviolet radiation and their mutational characteristics were studied, but little is known about the relative sensitivities of cell metabolism to uv damage in these different strains of yeast. We have therefore examined the initial effects of uv radiation on protein synthesis, RNA synthesis and cell division. (auth)

Radiation Effects on Plants (External Source)

Refer also to abstract 17957.

17964 (ORO-2583-9) CYTOLOGICAL STUDY OF RADIATION INDUCED ALTERATIONS IN CYTOPLASMIC FACTORS CONTROLLING MALE STERILITY IN CORN. Progress Report, February 28–December 1, 1971. Edwardson, John R. (Florida Univ., Gainesville. Dept. of Agronomy). Contract AT(40-1)-2583. 24p. Dep. NTIS.

Fertile selections from gamma-irradiated T-type corn have been shown to be resistant to infection by race-T of Helminthosporium maydis, while selections segregating fertile and sterile lines have been susceptible to race-T infection. Segregating populations from irradiated and chemically treated T-sterile lines will be examined for sterile-resistant segregants. Dominant genes inducing male sterility in restored S-type corn are being studied. Seed transmission and cytological studies of Blakeslee's Q-virus are under way. A search is in progress for abnormal appearing cytoplasmic organelles to assist in cytology of the fertilization process. Cytoplasmic male sterile and normal lines of several species are being compared cytologically for consistent differences in cytoplasmic constituents. Consistent differences between male sterile and normal Vicia faba lines have been observed. Spherical bodies, consisting of a membrane surrounding a central fibrous network have been observed in root, shoot, leaf, pollen and ovule tissues of sterile plants; they have not been observed in restored sterile lines, restorer lines, or in maintainer plants protected from vectors. (auth)

17965 (STI/DOC-10/131) RICE BREEDING WITH INDUCED MUTATIONS. III. Report of an FAO/IAEA Research Co-ordination Meeting Held in New Delhi, India, 22–25 September 1969. (International Atomic Energy Agency, Vienna (Austria)). Sep 1971. 203p. (CONF-690984). IAEA $5.00.

Separate abstracts were prepared for fifteen papers presented at the conference. An additional four papers were included on various aspects of rice breeding. (H.L.W.)

For abstracts of individual papers see: 17983–17997.

17966 MODIFICATION OF THE FREE AMINO ACID CONTENT IN ZERNA INERMIS (LEYS.) LINDIM PLANT UNDER THE INFLUENCE OF SEED IRRADIATION WITH ^{60}Co GAMMA RAYS. Hurghisiu, I.; Brezeanu, A.; Titu, H. Rev. Roum. Biol., Ser. Bot.; 16: No. 2, 119-23(1971).

Experiments were performed on Zerna inermis plants obtained from ^{60}Co-irradiated seeds in doses of 5000 R, 10,000 R, and 15,000 R. A series of modifications were revealed in the leaves during very early stages (30 days after seeding). With low radiation doses (5000 R), the number of free amino acids decreases as against control (plants obtained from non-irradiated seeds). High radiation doses (100,000 and 15,000 R) excessively increased the free amino acid content. In advanced stages (90 days after seeding), when strong ramification of the axial system occurred, a decrease in the number of amino acids as against control was recorded compared to the preceding stage; in plants obtained from seeds exposed to low radiation dose, a rise of free amino acids was noted, while seeds exposed to average and high radiation doses yield plants with fewer amino acids as against control. The findings emphasized that the number of free amino acids varied within one and the same species in terms of seed in radiation dose, the organ studied, and vegetation stage. (Rom. Sci. Abstr.)

17967 MUTATIONS INDUCED BY IRRADIATION OF GAMETOPHYTES IN BARLEY. Donini, B.; Devreux, M. (CNEN, Rome). Genet. Agr.; 24: 208-9(1970). (In Italian). (RT/-BIO(71)17).

Barley plants of cv. Leonessa, grown in pots, were acutely irradiated in a gamma field (^{60}Co source) with 1500 R (93 R/h) at heading stage. The spikes were treated at the various stages of gametophyte development: male, female or both gametophytes were irradiated. The chlorophyll and morphological mutation analysis at seedling stage reveals that barley M_1 plants are completely heterozygous for mutation induced after haplophyte irradiation. Among the 2396 M_2 progenies grown in fields, morphological mutations concerning plant size, waxless, tillering, spike size and shape, flower-row number, caryopse size and shape, earliness, and various types of sterility were isolated. The mutation frequency expressed as number of M_1 segregating plant progeny of the total progenies analyzed was 16.34%, 8.89%, and 28.69% respectively after irradiation of male, female, and both gametophytes. No difference in the mutation frequencies and spectra, according to the successively irradiated gametophyte developmental stages was observed. The segregation analysis, in the progenies of 6 M_1 heterozygous plants for chlorophyll mutation associated with a large deficit of recessives, has confirmed the persistence of the deficit in the three generations analyzed. Among the isolated mutations, an erectoid and an early type were multiplied for their large agronomic interest. (auth)

17968 PROTECTIVE INFLUENCE OF CYSTEINE AND GLUTATHIONE AGAINST RADIATION INDUCED CHROMOSOME DAMAGE IN HORDEUM VULGARE ROOT TIPS. Reddy, S. B. (Karolinska Institutet, Stockholm). Caryologia; 24: No. 1, 41-7 (Jan-Mar 1971).

Experiments were performed to study the protective property of 5×10^{-2} M cysteine and 2×10^{-3} M glutathione against radiation induced chromosome damage in the root tips of Hordeum vulgare. The protective ability was examined by scorings in anaphase cells 24 hrs after 200, 400, and 600 R of x irradiation. It was found that cysteine showed a more significant level of protection against radiation induced chromosome fragments, fragments and bridges, or bridges than did glutathione. The protection was obtained when the root tips were treated with the solutions for 30 min just before irradiation and also during irradiation. (auth)

17969 EFFECTS OF LOW DOSES OF X RAYS ON ROOTING AND YIELD OF CARNATION "WILLIAM SIM." Bors, J.; Zimmer, K. (Technische Univ., Hanover). Gartenbauwissenschaft; 36: No. 3, 209-14(1971). (In German).

Rooted and unrooted cuttings of carnation "William Sim" were irradiated with x rays in 12 different doses (0 to 10,000 R). Rooting response, number of flowers, length of internodes, number of nodes, stem length, and diameter of flowers were recorded for 8 month's after planting. Root formation and root growth was promoted in unrooted cuttings by doses of 80 to 600 R. In rooted cuttings, irradiation did not promote root growth. Further growth, yield, and quality of flowers was not promoted in both rooted and unrooted cuttings. Higher doses decreased root formation, growth, and yield. (auth)

17970 INDUCTION OF CHIMERA IN RICE BY IONIZING RADIATIONS. Majumder, B. (Univ., Milan). Bull. Bot. Soc. Bengal; 22: No. 1, 37-9(1968).

Dry seeds of the rice varieties Marichbati and Dular were treated with different doses of x rays (25, 50, and 75 kR) and ^{32}P (5, 10, and 15 μc/seed). In the first generation a number of plants were selected with respect to chimera characters, i.e., chlorophyll

deficiency, change in anthocyanin pigmentation, and pollen sterility. Some of these changed characters were maintained in subsequent generations. (Indian Sci. Abstr.)

17971 MORPHOLOGICAL AND PHYSIOLOGICAL EFFECTS OF RADIATIONS AND RADIOISOTOPES ON POTATOES, SOLANUM TUBEROSUM L. Jauhar, P. P. (IARI, Delhi). Indian J. Agr. Sci.; 39: No. 1, 88-100(1969).

The mutagens, γ radiation, ultraviolet radiation, EMS, and radioactive isotopes (^{32}P, ^{35}S, and ^{45}Ca), were used to induce mutations in three varieties of potatoes. The somatic aberrants or physiological variants included fused leaved, simple-leaved, multileafletleaved, bunchy-type, chlorophyll-deficient, and aerially tuberizing plants. A wide range of variation in the shape of tubers and structure of tuber skin was observed. Fused and knobby tubers, white tubers, and russetted tubers were noticed. Stimulatory effects of radioisotopes on tuber sprouting and growth, and on tuberization and yield, and of γ rays on flowering, were also observed. (Indian Sci. Abstr.)

17972 STIMULATION OF ACTION POTENTIALS WITH RADIATION IN SINGLE CELLS OF NITELLA GRACILIS. Gaffey, C. T. (Univ. of California, Berkeley). Int. J. Radiat. Biol.; 21: No. 1, 11-29(Jan 1972).

All-or-none action potentials from single algal cells, Nitella gracilis, were stimulated with ionization radiation. Short pulses (0.1 to 2.0 sec or more) of α-particles (^{4}He nuclei) were restricted to a 13% segment of mature, internodal cells. Radiation intercepted cells between stimulating and recording reversible electrodes. Individual pulses of α-particles were presented to each cell to test if they could cause excitation. The electric threshold for excitation was routinely determined prior to and after radiation. Initiation of action potentials required about 1 to 2×10^5 rads/sec of α-particles, although dose-rates from 0.05 to 2.00 Mrads/sec were available. The amount of radiation necessary to trigger an action potential depended upon the radiation previously absorbed by each cell. The radiation threshold (dose and dose-rate) for excitation steadily increased as a function of the accumulated dose. Electric shocks, applied to a non-irradiated segment of each cell, revealed that the electric threshold for excitation remained unchanged until the segment being irradiated absorbed 20–23 Mrads of α-particles. Propagated action potentials were blocked when cells absorbed 28 Mrads (average) of α-particles delivered in fractionated doses. Nitella cells ruptured when given a single exposure of 4 to 5 Mrads of radiation. Rotational streaming of endoplasm of Nitella cells was observed by closed-circuit T.V. Cessation of cyclosis was induced with less radiation than required to initiate excitation. (auth) (UK)

17973 GROWTH AND MORPHOGENESIS OF PECAN UNDER THE EFFECT OF γ-RAYS ^{60}Co. Lebedinets, L. N. (Donetsk State Univ., USSR). Tsitol. Genet.; 5: No. 1, 45-8(Jan-Feb 1971). (In Russian).

Under the effect of low doses of irradiation (1000 to 3500 R) the seed germination was stimulated and the growth of seedlings was intensified. Higher doses of irradiation inhibited the pecan seedlings. Somatic mutations concerning the shape and size of leaves were observed. (auth)

17974 CYTOGENETIC NATURE OF INDUCED PEA MUTANTS. Kalinina, N. P.; Sidorova, K. K. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Tsitol. Genet.; 5: No. 1, 34-8(Jan-Feb 1971). (In Russian).

Meiosis was studied in 12 pea mutants and an analysis of hybrids was carried out. It was established that seven lines were typical point mutations. The genetic composition of the other five lines was related to structural alterations of chromosomes such as deficiencies, duplications, small inversions, or point mutations. The disturbance of chromosome pairing was related to the pleiotropic effect of the mutant gene. It was found that chemical mutagens and ionizing radiations were capable of inducing inheritable structural alterations in chromosomes that survived to meiosis. A specificity in the effect of different mutagens was found. Inversions were found only in radiation mutants. An increased natural mutability was characteristic of some mutants. (H.L.W.)

17975 GENETICALLY DETERMINED ABNORMALITIES OF INFLORESCENCE DEVELOPMENT AND OF FLOWER FORMATION. Klein, H. D.; Milutinovic, M. (Univ., Bonn). Theor. Appl. Genet.; 41: No. 6, 255-8(1971). (In German).

Results are reported from a histological study of two sterile mutants of Pisum sativum induced by x-rays and neutrons. Individuals of the mutant 2228 are characterized by failure to develop sexual organs. In the nucellus as well as in the anthers no sporogenous cells are differentiated. Instead, a homogenous mass of cells can be seen to fill the organs, it degenerates sooner or later. In the mutant 172 A no inflorescences are developed at all, so that the change from the vegetative to the generative phase of the plants is blocked. Instead of normal inflorescences so-called vegetative inflorescences are produced. Comparative histological studies showed that in this mutant there remain no residual potentialities in either the shoot tips or the leaves. (auth)

17976 CHROMATID ABERRATIONS INDUCED BY π^- MESONS IN VICIA FABA ROOT MERISTEM CELLS. Gnanapurani, Madhvanath (Univ. of California, Berkeley); Raju, Mudundi R.; Richman, Chaim; Wolff, Sheldon. Int. J. Radiat. Biol.; 21: No. 1, 49-56(Jan 1972).

Chromatid aberrations were induced in Vicia faba root meristem cells by 31, 92, and 117 rads of π^- mesons at the peak of the depth–dose distribution. The irradiation was carried out under both aerobic and anoxic conditions. The yields of various types of aberrations were obtained in cells at 4-hour intervals up to 24 hours after irradiation. A rough estimate of the oxygen enhancement ratio indicated it was 1.8. In cells irradiated at the peak of the depth–dose distribution the aberrations were not distributed among cells according to random expectations. Too many cells had no aberrations and too many had multiple aberrations. It is suggested that this was a reflection of the way in which energy is dissipated when a π^- meson stops and produces stars in the medium. (auth) (UK)

17977 X IRRADIATION STUDIES ON TRIGONELLA FOENUM-GRAECUM L. Singh, A.; Roy, R. P. (Patna Univ., India). Genet. Iber.; 23: No. 1-2, 49-66(1971).

Dry seeds of Trigonella foenum-graecum were x irradiated with 5,000, 10,000, 15,000, 20,000 and 25,000 R. The critical dose for this species was 20,000 R. The relationship between frequency of cells having chromosomal translocations and x-ray dose was found to be linear. Formation of only bivalents in rare pollen mother cells having duplicated chromosome number supports the view that chromosome pairing and multivalent formation are under genetic control. R_2 generation showed considerable variability and some promising plants were selected for further breeding work. It was found that high doses increase the efficiency of mutation production. (auth)

17978 TEMPERATURE EFFECT BEFORE X-IRRADIATION ON THE APPEARANCE OF CHROMOSOME ABERRATIONS IN WHEAT. Babayan, R. S. (Laboratory of Induced Mutagenesis Plants, Erevan). Tsitol. Genet.; 4: No. 4, 324-7(Jul-Aug 1970). (In Russian).

A short-term (10 min.) heating of wheat seeds at 70°C (dry seeds) and 40° (soaked seeds) decreased the yield of chromosome aberrations induced by x irradiation. The longer the interval between heating and irradiation of seeds, the greater was the effect of heating. It is supposed that after thermal actions the restoration of the induced changes in seeds takes place and this leads to the change in radiosensitivity. (auth)

17979 COMPARATIVE STUDY OF SYNCHRONIZATION OF CELL DIVISION IN ROOT MERISTEM OF NON-IRRADIATED AND γ-IRRADIATED PEA SEEDLINGS. Gudkov, I. N.; Grodzinskii, D. M. (Inst. of Plant Physiology, Kiev). Tsitol. Genet.; 4: No. 6, 509-12(Nov-Dec 1971). (In Russian).

Maintenance of pea seedlings non-irradiated and irradiated with the 800 rad dose of ^{60}Co γ rays in a nutrient mixture containing 5-aminouracil (0.07%) caused partial synchronization of cell division in root meristem. Two fading peaks of synchronization were observed, the period of time between which corresponded to duration of the mitotic cycle. Synchronization of irradiated seedlings occurred later than that of non-irradiated ones and duration of the mitotic cycle was longer. The maximum quantity of synchronously dividing cells in irradiated seedlings was considerably lower than that in non-irradiated seedlings, however the probability of cells entering mitosis was the same. A comparative study of cell division synchronization in root meristems of non-irradiated and irradiated seedlings allows to suppose that the effect of ionizing radiation causes injuries in regulatory processes providing for the inclusion of cells into mitosis in due time, as well as the normal course of the mitotic cycle and its duration. (auth)

17980 EFFECT OF DIFFERENT DOSES OF RADIATION AND CHEMICAL MUTAGENES ON THE MUTATION FREQUENCY IN COTTON VARIETIES. Kuliev, A. M.; Kononenko, A. V.; Shirinov, I.; Sarkhanbeili, Yu. (Inst. of Genetics and Selection, Baku). Tsitol. Genet.; 4: No. 6, 540-6(Nov-Dec 1971). (In Russian).

The effect was studied on cotton seeds of several varieties of

different doses of γ rays, electric field, ethylenimine, and colchicine in different concentrations and under different exposures. Of all the mutagens under study, the best stimulating effect was shown by γ rays at a dose of 0.5 to 10 krad, ethylenimine—0.03%, and electric field γ = 2500 V at an exposition of 60 sec. The greatest amount of different cotton mutations including those with economically valuable properties was obtained by irradiating seeds on a γ installation at a dose of 10 krad and treating dry seeds with colchicine of a concentration of 0.05% for 30 hrs and by treating the germinating seeds with 0.03 to 0.04% colchicine for 24 hrs. It is also established that different varieties of cotton respond differently to the action of physical or chemical mutagens. (auth)

17981 PECULIARITIES OF THE DIPLOID AND AUTOTETRAPLOID BUCKWHEAT RESPONSE TO γ-IRRADIATION OF SEEDLINGS AND RESTING SEEDS. Dovzhenko, L. I. (Inst. of Biological Development, Moscow). Tsitol. Genet.; 4: No. 5, 417-21 (Sep-Oct 1971). (In Russian).

The results of studying the dynamics of chromosome rearrangements and mitotic activity in the first cellular cycle after irradiation of seedlings and resting seeds of the diploid and autotetraploid buckwheat are presented. After irradiation of seedlings (γ rays, ^{137}Cs, 300 rad), the frequency of cells with chromosome rearrangements in the tetraploid form is twice as high as in the diploid one. After irradiation of the resting seeds (γ rays, ^{137}Cs, 7000 rad), the frequency of cells with chromosome rearrangements is almost similar in the diploid and tetraploid form. (auth)

17982 MUTAGENIC PROCESS IN FODDER BEANS. Chang Ming Nam; Valeva, S. A. (Moscow State Univ.). Tsitol. Genet.; 4: No. 5, 431-6(Sep-Oct 1971). (In Russian).

The cytogenetic and genetic response of fodder beans to γ irradiation and treatment of seeds with ethylenimine was studied. A considerable number of mutations, including chlorophyll mutations were obtained. Some chlorophyll mutations proved to be viable. The changed number and structures of chromosomes not always results in changes of the phenotype. Most of the mutations proved to be recessive and only three—dominant ones. The latter are associated with translocations and inversions. (auth)

17983 YIELD PERFORMANCE OF PROMISING RICE MUTANTS AND HYBRID SELECTIONS. Bari, G.; Awan, M. A.; Bhatti, I. M. (Atomic Energy Agricultural Research Centre, Tandojam, West Pakistan). Contract No. 290/RB. pp 1-4 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Sixteen strains of rice developed through irradiation-induced mutations and conventional breeding methods in different rice-growing countries were tested for their yield performance. Six of these strains, namely: I-kung-bau 4-2(5788.34 kg/ha), IR 8-288-3 (4879.37 kg/ha), Taichung (Native) 1 (4861.88 kg/ha), NP 130 mutant S-1 (4703.51 kg/ha), Shung-chiang 30-21 (4688.94 kg/ha) and Yuang-hsing 1 (4610.90 kg/ha), gave significantly higher yields than the local standard variety Kangni-27 (4336.70 kg/ha). All these strains were short statured compared with the local Kangni-27. Four of these strains, i.e., I-kung-bau 4-2, NP 130 mutant S-1, Shung-chiang 30-21 and Yuang-hsing 1, were developed through mutation breeding and the remaining two, i.e., IR 7-288-3 and Taichung (Native) 1, by conventional breeding methods. (auth)

17984 INDUCTION OF MUTATIONS IN RICE. THEIR NATURE AND USE FOR RICE IMPROVEMENT. Escuro, P. B. (Coll. of Agriculture, Laguna, Philippines); Guevarra, A. B.; Tepora, J. N.; (and others). Contract No. 283/RB. pp 5-17 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Breeder seeds of six recommended and two old commercial varieties of lowland rice which are medium to late maturing, tall and weak-strawed were exposed to different mutagens and the M_1 and succeeding generations were grown in the U.P. College of Agriculture to screen for high-yielding mutants which possess early maturity, short stature and lodging resistance. Results from the isolation of beneficial mutants from segregating progenies indicate that varieties respond differently to different mutagens. The largest number of mutants was induced in the Peta variety. Gamma irradiation and EMS treatment produced more mutants than the other mutagens. Most of the promising true-breeding lines were obtained from progenies of seeds exposed to 20, 35 and 45 kR gamma rays and to 0.5 and 1.0% EMS. Evaluation in performance tests of true-breeding lines indicate further the superiority of gamma irradiation on Peta variety. Eleven of the 13 mutant lines which gave significantly higher yields than the Peta check were derived from progenies of seed that had been gamma irradiated with doses between 20 and 35 kR. These lines are also earlier maturing, shorter statured, more lodging resistant, have a higher harvest index and more erect leaves than the check. Erect leaf posture is desirable as it enables greater interception of sunlight for photosynthesis, particularly during the rainy season when light intensity is greatly reduced. (auth)

17985 EVOLUTION OF NEW RICE VARIETIES BY RADIATION-INDUCED MUTATIONS IN H_4 AND H_8 RICE VARIETIES. Gahashan, P. (Agricultural Research Station, Maha-Illuppallama, Ceylon). Contract No. 387/RB. pp 19-28 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Mutational experiments were undertaken at the Agricultural Research Station, Maha-Illuppallama from 1967 to the present to evolve new rice varieties using the popular local varieties H_4 and H_8. A high-yielding mutant line, MI-273 (m), has been selected from a 35-kR γ-irradiation treatment of H_4. The MI-273(m) mutant has shorter culm, relatively darker green leaves and an erect growth habit. In the dry zone, the yield of MI-273 (m) in the Maha season is about the same as that of IR-8, but a little lower than in the Yala season. In the wet zone, the yield of MI-273(m) is always higher than that of IR-8. The difference in yield of MI-273(m) in the Maha and the Yala is small (5–5.7 Bu/acre) as compared with H_4, IR-8 and Bg-11-11 (15–23 Bu/acre). This suggests that this mutant variety may be recommendable in both the Maha and the Yala seasons. (auth)

17986 BREEDING FOR EARLY, HIGH-YIELDING AND DISEASE-RESISTANT RICE VARIETIES THROUGH INDUCED MUTATIONS. Haq, M. S.; Rahman, M. M.; Masur, A.; Islam, R. (Atomic Energy Centre, Dacca, East Pakistan). Contract No. 493/RB. pp 35-46 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Dormant seeds of the introduced variety IR-8 and ten other local recommended varieties of Aus, Aman and Boro rice were irradiated with a 30-kR dose of γ rays from a 500-Ci ^{60}Co source at the Atomic Energy Center, Dacca. A wide range of variation in culm length and maturity period of M_2 progenies was observed in almost all the varieties of Aus and Aman. In all, 13 mutants from these varieties were found to be of practical value, directly or indirectly, as recorded from their performance in M_3. The most promising of them were the four mutants of IR-8 and the two of Dular. IR-8-20 and IR-8-24 were earlier than the parent by about 10 days and IR-8-38 and IR-8-39 were earlier by 21-25 days. They also maintained fairly high yields comparable to IR-8. Performance of these mutants up to M_4 generation was more or less consistent with regard to earliness and yield per acre under different growing seasons. Mutants of Dular (Dular 298 and 250) were semi-dwarf type. They matured with the mother variety and produced more than double yield of the parent. Nizersail-95, a short mutant, and Nizersail-102, an early mutant of Aman rice outyielded their mother in M_3. Two short mutants of Habj. II (Habj. II-43 and Habj. II-56) gave nearly the same yield as the parent in M_3, but in M_4 they outyielded the parent. The other three mutants appeared superior in certain characters but their yields were very poor in M_3. The two mutants of Dular and two of IR-8 (IR-8-38 and IR-8-39) recorded a higher percentage of protein compared to their mothers and other standard varieties. IR-8 mutants are in zonal trials and a hybridization program involving mutants is in progress. (auth)

17987 RICE BREEDING WITH INDUCED MUTATIONS IN THAILAND: REVIEW OF STUDIES MADE OVER A FIVE-YEAR PERIOD. Khambanonda, Pricha (Ministry of Agriculture, Bangkok). Contract No. 291/RB. pp 61-76 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

During the period 1964–1966, 12 Thai varieties were subjected to seed treatment with γ-rays, fast neutrons or EMS to induce mutants with improved disease resistance, straw stiffness and responsiveness to fertilizer. Recently (1968–1970) eight hybrid selections from crosses of IRRI × Thai native varieties and two

named IRRI varieties were subjected to seed treatment in order to improve one or two defective characters. Selection and screening of mutants were practiced on an individual plant basis using M_2 lines which originated from individual M_1 panicles. Selected mutants which showed promise were included in observation tests and/or yield trials. A rather large amount of material has been handled in the 11 experiments. Mutants which appeared defective in important agronomic characters were discarded during the course of breeding. The results to date show that promising mutant lines exhibiting early maturity, short height, improved disease or pest resistance, high-yielding capacity or glutinous endosperm were induced by treatment with the mutagens. The frequencies of promising mutants, however, were generally very low. Four high-yielding mutants are in the final stage of yield testing. Several other promising lines will be further tested for their yielding abilities and other agronomic characters. The material which originated from treatments in 1968–1970 are still in early generations. Promising mutants obtained from the mother varieties which required changes in only one or two characters, such as disease resistance, early maturity or endosperm are at present under selection or seed multiplication for use in additional tests of their general characteristics. (auth)

17988 INDUCED MUTATIONS IN RICE. Miah, A. J.; Awan, M. A. (Atomic Energy Agricultural Research Centre, Tandojam, West Pakistan). Contract No. 290/RB. pp 77-89 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Seeds of six indica-type varieties of rice, namely Dokri Basmati, Kangni-27, Jajai-77, 370 Basmati, IR-6 and IR-8, were treated with physical and chemical mutagens in six experiments during 1964–1969. Mutation spectra and mutation frequency were studied, and mutants of economic importance were selected from the irradiated progenies. Only dwarf and short-culm mutants were found in variety Dokri Basmati. From variety Jajai-77, early and late maturing mutants were selected. Some early mutants showed no marked reduction in yield. A fine grain mutant, which matured in 100 days as compared to 130–135 days in the control, was selected from the irradiated progeny of IR-8. EMS and γ rays were found to give the highest mutation frequency for varieties 370 Basmati and IR-8 respectively. (auth)

17989 MUTAGENIC EFFECTIVENESS AND EFFICIENCY OF GAMMA RAYS, FAST NEUTRONS, AND ETHYL METHANE SULPHONATE IN RICE. Mikaelsen, K. (International Atomic Energy Agency, Vienna); Karunakaran, K.; Kiss, I. S. pp 91-6 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Experiments with mutagen treatments of rice seeds with γ radiation, fast neutrons and ethyl methane sulphonate (EMS) were carried out to compare the mutagenic effectiveness and efficiency of these three types of mutagens. The variety Dunghan Shali was used as experimental material in these studies and the comparisons were made on the basis of chlorophyll mutation frequencies which were recorded in the young seedling stage. Seeds were irradiated with the following doses: 16, 18, 20 and 22 krad of γ radiation; 1.6, 1.8, 2.0 and 2.2 krad of fast neutrons. For the EMS treatments, the seeds were presoaked for 30 h at 25°C and treated in a 2.0% EMS solution for 2 h at 25°C. One sample was planted out immediately (wet) and another seed lot was dried back and stored for 7 days (dry-back) before planting. The EMS treatments yielded the highest mutation frequencies and a higher rate of viable mutations compared with the radiation treatments. On the basis of chlorophyll mutation frequencies, the EMS treatments gave better mutagenic efficiency and effectiveness than did the doses of γ radiation and fast neutrons that were applied. Fast neutrons proved to be more effective, but not more efficient, than γ radiation. These results should not be interpreted to mean that EMS is a better mutagen than γ radiation or fast neutrons for producing beneficial mutations for practical plant breeding. (auth)

17990 EARLY MATURING MUTANT: ITS VALUE IN BREEDING FOR DISEASE RESISTANCE IN RICE. Mikaelsen, K. (International Atomic Energy Agency, Vienna); Saja, Z.; Simon, J. pp 97-101 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

In 1966, seeds from the variety Cesariot were irradiated with γ radiation and fast neutrons to produce early maturing plants by means of mutations. Selection for early maturing plants was started in the M_2 generation. One mutant selected from a treatment with fast neutrons headed 3 to 4 weeks earlier and matured 2 to 3 weeks earlier than the mother variety in the M_3, M_4, and M_5 generations (1968–70). The good resistance against lodging and blast disease of the mother variety was maintained in the mutant line. In 1970, the mutant line was tested in yield trials and the results showed that it yielded as much as the highest existing varieties. This may indicate that the mutant can be used directly as a new variety. The paper also points out that the mutant Early Cesariot will be a very useful parent in cross-breeding programs because it has several desirable characteristics of agronomic value. (auth)

17991 STUDIES ON EMBRYO DEVELOPMENT AND CHANGES IN SENSITIVITY TO GAMMA RADIATION AND ALKYLATING AGENTS (MMS AND EMS) IN RICE SEEDS DURING SOAKING IN WATER. Osone, K.; Mikaelsen, K. (International Atomic Energy Agency, Vienna). pp 103-15 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Seeds from a Hungarian variety Dunghan Shali were soaked at 25°C and treated with 5 and 15 krad of gamma radiation, 0.05 and 0.15% of MMS and 0.5 and 1.5% of EMS, all of which indicated equivalent effects on non-soaked seeds. The seeds soaked in MMS and EMS were treated for 2 hours and post-washed for 16 hours in running tap water. Seedling growth was used as the criterion for studying the effects of mutagen treatments on rice seeds. Three different stages could be defined during 72 hours of soaking. The first stage was in the seed embryo soaked for 0–6 hours where the sensitivity to MMS and EMS decreased. The rapid increase in water content suggested that physical swelling of the embryos proceeded during this stage. The second stage was in the 6 to 30-hour soaking period where the sensitivity to gamma radiation, EMS and MMS increased slowly. Slow increases in water content, ^{14}C-MMS uptake rate and RNA synthesis indicated a slow increase of metabolic activity during this stage. The third stage appeared after more than 30 hours of soaking when the sensitivity to gamma radiation, EMS and MMS increased rapidly. The rapid increase in sensitivity corresponded with the increasing rate of DNA synthesis and subsequent cell division during this stage. Some useful information for mutation experiments was drawn from the experimental results: (MMS uptake rate for the seed embryos varied at different soaking times. Dehusked seeds absorbed more than twice as much MMS as hulled ones at an early stage, but after sprouting the differences were insignificant. More than 12 hours of post-washing was needed to wash out the chemical from the treated seed embryos. M_1 seedling growth reduction was partly caused by delayed leaf development and therefore reduced leaf length and relative seedling growth was not constant during the first days of germination. Relative biological efficiency was estimated on the basis of 50% M_1 seedling growth reduction which gave the following corresponding doses for the various types of treatments: 24 krad for gamma radiation, 0.27% for MMS and 2.25% for EMS. (auth)

17992 PRESENT STATUS OF RICE BREEDING IN INDUCED MUTATIONS IN GUYANA, S. AMERICA. Pawar, M. S. (Central Agricultural Station, Guyana, S. America). pp 117-29 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

From 1966 to 1969 twenty varieties, including three selections, sixteen hybrids and one mutant, were irradiated with γ rays and fast neutrons at nine different levels each. The earliest irradiated material has reached the M_7 stage and yielded fifty-two mutants. The mutants mature very early, resist lodging, possess short stature, give a high and moderate yield, and have long slender grains. The best among them, M 643-4, gave a yield of 5572 kg/ha as against 2940 kg/ha recorded by the most popular variety, B.G. 79, when grown under identical conditions. So, 350 kg of seed of this mutant has been supplied to four progressive farmers for testing during autumn 1970. Twenty-one of these mutants have given protein yields of more than 10%, with M 554-1 having 12.11%. Efforts are being made to get an amino-acid assay of six lines with the highest protein content. Two varieties, G 593 and 739, were found to be the most radiosensitive in the experience of the IAEC so work on these was terminated. Work on other varieties is in progress. (auth)

17993 INDUCED MUTATIONS FOR RICE IMPROVEMENT IN KOREA. Ree, J. H. (Yungnam Crop Experiment Station, Milyang, Korea). Contract No. 547/R3/RB. pp 131-47 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

In 1966 seeds of the leading rice variety, Palkweng (japonica type), were irradiated with x rays and thermal neutrons at the Institute of Atomic Energy in Seoul. The mutagen-treated rice was grown at the Yungnam Crop Experiment Station at Milyang, Korea, for selection of mutants of economic importance. Data from the field selection of the 292 M_3 lines indicated that panicle length, weight of the panicle per plant and kernel weight were slightly associated with culm length. A number of short-statured, lodging-resistant mutants have been selected from the progenies of treated seeds. Two blast-resistant lines (M_3-514 and M_3-515) were isolated in 1968. Their progenies have been tested and four mutant lines (48-514-102, 48-515-103, 48-515-106 and 48-515-118) were developed which breed true for leaf-blast resistance. Furthermore, two promising mutant lines, MR 520-281-127 and MR 517-277-110 (named Milyang No. 10), were selected. In 1970, Milyang No. 10 and the mother variety, Palkweng, were tested for their fertilizer response with different levels of fertilizer. Growth characteristics, protein content and blast-disease resistance of this mutant line were also studied. Compared with the parent variety, Milyang No. 10 was found to be shorter, to have more grains per panicle, the same yield and a slightly higher protein content. (auth)

17994 EFFICIENT TREATMENT OF RICE SEEDS WITH MUTAGENS AND SELECTION FOR USEFUL PLANT TYPES. Soriano, J. D. (Univ. of the Philippines, Quezon City). pp 149-55 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

The influence of different factors on the response of rice seeds to γ rays and chemical mutagens was determined. The results of these experiments were applied in the selection of mutants with good grain quality. (auth)

17995 FREQUENCY AND SPECTRUM OF MUTATIONS INDUCED IN RICE VARIETIES BY PHYSICAL AND CHEMICAL MUTAGENS. Swaminathan, M. S.; Siddiq, E. A.; Ismail, M. A.; (and others) (Indian Agricultural Research Inst., Delhi). pp 157-70 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Mutation research in rice has been continued with the following objectives: Standardization of treatment techniques; Increasing the recombination frequency in indica-japonica hybrids; and Manipulation of the quantity and quality of proteins through mutagen treatments. The relative efficiency of the use of dehusked seeds and chemical carriers, such as dimethyl sulphoxide, and treatments with mutagens under different pressures was studied in relation to the diffusion of chemical mutagens. Treatment of seeds with EMS under a pressure range of 2–5 atm was found to be very effective. The effect of different durations of presoaking on the frequency and spectrum of mutations in treatments with EMS, NMU and dES were studied in detail. Three major peaks of sensitivity were located and they appear to coincide with the beginning of the S-phase of DNA replication, asynchronous replication of DNA during the S-phase and a sensitive stage in G_2. Besides the frequency, the spectrum of both lethal and viable mutations was also found to vary with a change in the metabolic state of the germinating seed. Recombination frequency with special reference to resistance to bacterial leaf blight in the segregating populations of irradiated indica × japonica hybrids was studied. A study of the extent of variation in protein content induced by mutagen treatments supports the view that mutation breeding often scope for improving the protein content and quality of rice. (auth)

17996 COMPARISON BETWEEN RADIATION-INDUCED AND SPONTANEOUS DIPLOID LINES DERIVED FROM A HAPLOID RICE PLANT. Tanaka, S. (Ministry of Agriculture and Forestry, Ohmiya, Japan). pp 171-81 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

A spontaneous haploid rice plant from an old leading variety, Norin No. 8, was propagated vegetatively and exposed to chronic γ rays. The quantitative characters (such as length of culm, length of panicle, number of panicles per plant and size of kernel) of radiation-induced diploid lines which had never segregated drastic mutants in any generation and spontaneous diploid lines which had been obtained during the propagations of non-irradiated haploid plants were compared with those of the control line (one of the spontaneous diploid lines) which had never shown any visible change of characters compared with the original variety Norin No. 8. In the line means of individual characters, some significant differences were found between the radiation-induced diploid line and the control line, while the standard deviations from the mean within individual radiation-induced lines were as small as, or smaller, than those within the control line. This fact indicates that chronic irradiation of growing haploid plants is an effective technique for obtaining pure mutant lines with changes of quantitative characters. (auth)

17997 INDUCED MUTATIONS FOR RICE IMPROVEMENT IN VIETNAM: PRELIMINARY REPORT. Thai-Cong-Tung; Nguyen-Van-Mung; Chau-Van-Hanh (Inst. of Agricultural Research, Saigon, Vietnam). pp 189-93 of Rice Breeding with Induced Mutations. III. Vienna; International Atomic Energy Agency (1971).

From Meeting on the use of induced mutations in rice breeding; New Delhi, India (22 Sep 1969). See STI/DOC-10/131; CONF-690984.

Two Vietnamese varieties of rice, Gíâu Dumont and Nâng Keo, and IR-8 from the Philippines were treated with three different doses of thermal neutrons. The effect of the different radiation doses on seed germination rate, seedling height, plant height and grain yield was studied. No difference in germination rate was found among the different doses of radiation treatment, but stimulation effects of irradiation on the plant height and grain were noticed. Variety Gíâu Dumont was found to be the most sensitive to radiation. (auth)

17998 CYTOGENETIC EFFECT OF CHRONIC AND SEMI-CHRONIC GAMMA-IRRADIATION IN BARLEY. Sutka, Jozsef Petrovics, Veronika (Univ. of Agricultural Sciences, Goedoelloe, Hungary). Acta Biol. Acad. Sci. Hung.; 22: No. 3, 301-8 (1971).

The cytogenetic effects of chronic and semi-chronic irradiation on barley plants grown at the gamma-field of Gödöllő were investigated at the time of microsporogenesis. The following chromosome aberrations were found most frequently: translocation rings and chains, iso- and pseudo-isochromosomes, inversions, bridges, and fragments. A higher frequency of the chromosome aberrations was observed with an increase in the dose intensity of chronic irradiation. The analysis of the cytogenetic effects of semi-chronic irradiation in the different stages of development (tillering, stalking, meiosis) showed that the most radiosensitive phase was meiosis. Relatively few chromosome aberrations were induced by the treatment during the tillering phase. (auth)

17999 ACCUMULATION OF CHLOROPHYLL IN THE PRIMARY LEAVES OF PHASEOLUS VULGARIS L., IRRADIATED IN THE PRESENCE OF AET AND CYSTAMINE. II. INFLUENCE OF AET AND CYSTAMINE ON THE CHLOROPHYLL ACCUMULATION. Kirchmann, R. (CEN/SCK, Mol, Belg.); Bonotto, S.; Bronchart, R. Radiat. Bot.; 11: No. 6, 419-23(Dec 1971). (In French).

Sixteen-day-old etiolated bean leaves were treated with AET and cystamine. The influence of the concentration and of the time of action of these compounds on chlorophyll accumulation after 24 hr under continuous light was investigated. Electron microscopic examinations of the slides of treated primary leaves showed that there was no effect of AET or cystamine either on the ultrastructure of plants or on their evolution during the greening process. A lack of radioprotection of chlorophyll accumulation, in γ-irradiated leaves, was observed and the results are discussed. (auth)

18000 PRODUCTION OF UNREDUCED GAMETES IN REMOTE HYBRIDS OF FRUIT CROPS BY MEANS OF CHEMICAL MUTAGEN ACTION AND γ-IRRADIATION. Chuvashina, N. P.; Pakhomova, N. P. (Central Genetics Lab., Michurinsk, USSR). Tsitol, Genet.; 5, No. 4, 351-8(Jul-Aug 1971). (In Russian).

The obtaining of meiotic polyploids is usually carried out by valent crossings, using diploid gametes of tetraploid forms. A new method is developed of producing diploid gametes in F_1 sterile hybrids of fruit and berry crops by acenaphthene and γ-ray treatment. This method promotes the directed production of F_2 meiotic allopolyploids. (auth)

18001 MODIFYING THE FREQUENCY OF CHROMOSOME ABERRATIONS INDUCED BY γ-RAYS UNDER TREATMENT OF BARLEY SEEDS WITH CHEMICALS. Levenko, B. A. (Inst. of Microbiology and Virology, Kiev). Tsitol, Genet.; 5: No. 4, 342-4(Jul-Aug 1971). (In Russian).

Frequency of chromosome aberrations of barley seeds was studied after soaking them in 0.005 and 0.05 M solutions of thiourea, cysteine, and ferrous chloride and irradiation with 10 and 20 kR doses of γ rays. Such treatment led to a decrease in γ ray-induced aberrations. This decrease was more pronounced with a 10 kR dose. (auth)

18002 NATURE OF MODIFICATION OF FAST NEUTRON MUTAGEN EFFECTS. Kulik, M. I.; Shkvarnikov, P. K. (Inst. Microbiology and Virology, Kiev). Tsitol. Genet.; 5: No. 4, 336-41(Jul-Aug 1971). (In Russian).

The mutagenic effect of extracts from pea and wheat seeds irradiated with fast neutrons was studied. With this purpose, irradiated and non-irradiated wheat seeds were germinated simultaneously in one Petri dish and after germinating chromosome aberration frequency was studied in sprouts of both. Frequency of aberrations, which arose in the sprouts of non-irradiated seeds under the effect of extracts that came separately from the coat and cotyledons of irradiated seeds, was studied in pea. In these experiments a trustworthy increase was established in frequency of chromosome aberrations in the non-irradiated seeds under the effect of extracts from the irradiated ones. In pea, the extracts from the coat and cotyledons of the irradiated seeds produced almost the same increase in aberration frequency, but the ratio of different types of aberrations in both cases was different. The substances from the coat of irradiated pea seeds possessing the mutagen effect are supposed to be products of melanin chemical transformation caused by irradiation. (auth)

Radiation Effects on Animals (External Source)

Man

Refer also to abstract 17750.

18003 (EUR-4732) DIAGNOSIS AND THERAPY OF RADIATION INJURIES OF MEN. Fliedner, T. M. (Ulm Univ. (West Germany)). Dec 1971. 84p. (In German). Dep. NTIS (U. S. Sales Only).

Problems which are of primary importance for understanding radiation injuries of mammals are reviewed. The improvement of existing and the development of new hematological methods of importance in the diagnosis of radiation injuries are discussed. Injuries resulting from acute, repeated, and chronic radiation exposure from external radiation sources or from incorporated radioactive isotopes of varying energy and dose rates are considered. The improvement of existing and the development of new clinical methods which are of importance in the treatment of radiation injuries of the hematopoietic system and secondary complications which may be observed as a consequence of the destruction of hematopoiesis are also discussed. It is pointed out that progress in the field of the diagnosis and therapy of radiation injuries can only be achieved to the extent that the physiology of the hematopoietic cell systems, including renewal kinetics and regulation, is understood. Research studies using rats for the study of the physiology and pathophysiology of hematopoietic insufficiency and its regeneration following irradiation are reported. (auth)

18004 RADIOLOGICAL FINDINGS IN THE LARGE INTESTINE AFTER RADIATION THERAPY. Koch, Walter (Univ. of Chile, Valparaiso); Rodewald, Maria L. Rev. Med. Chile; 99: No. 11, 843-7(Nov 1971). (In Spanish).

Late effects of radiation on the large intestine of 34 patients aged 27 to 70 yr and affected by Grade I or II Cervico-uterine cancer were studied by x ray serially. Eight of the patients showed what seem to be transient inflammatory or spastic changes. Nine other patients developed persistent and progressive narrowing of the intestinal lumen or rigidity of the intestinal wall. These manifestations occurred at the rectal or sigmoidal level, extending through to a variable degree at the distal ascending colon. (auth)

18005 RADIATION INDUCED MENINGEAL FIBROSARCOMA. Schrantz, James L.; Araoz, Carlos A. (Univ. of Arkansas, Little Rock. Veterans Administration Hospital, Little Rock, Ark.). Arch. Pathol.; 93: No. 1, 26-31(Jan 1972).

The development of sarcomas in tissues exposed to ionizing irradiation has been documented for years. In spite of this known effect of irradiation, only four cases of meningeal sarcoma have been reported. The improving survival rate of patients treated for cerebral tumors should result in an increasing number of sarcomas in the irradiated tissues. Histologically, meningeal sarcomas are similar to fibrosarcomas of other soft tissues. Sarcomatous areas of the sarcomatous gliomas are similar to fibrosarcomas of meninges. However, pathologists utilizing the phosphotungstic acid-hematoxylin staining technique will readily recognize the blue staining glial fibers of sarcomatous gliomas and their absence in meningeal fibrosarcomas. An unusual feature in our case was the vertebral metastasis. (auth)

18006 LATE RESULTS OF LOW-VOLTAGE X-RAY THERAPY AND SPONTANEOUS REGRESSION OF SKIN HEMANGIOMAS IN CHILDREN. Svistunova, T. M.; Abshilava, D. I. (Research Inst. of Oncology, Leningrad). Vop. Onkol.; 17: No. 9, 99-104(1971). (In Russian).

A comparison of late results (from 5 to 10 yrs and longer) of low-voltage x-ray therapy of 123 hemangiomas and spontaneous regression of 108 skin hemangiomas of the face and body in the spinal region has demonstrated that a complete clinical cure could be gained in 100 percent of cases while using low-voltage x-ray therapy and only in 67.6 percent in their spontaneous disappearance. The entire disappearance of hemangiomas after low-voltage x-ray, therapy was gained in 51.2% of cases and in 13.9% as a result of spontaneous disappearance. The formation of a scar and slight skin atrophy as a result of low-voltage x-ray therapy of skin hemangiomas in the spinal region were observed in 28 percent. Traceless spontaneous disappearance of hemangiomas of the mentioned localizations occurred only in 15% of cases. Low-voltage x-ray therapy of skin hemangiomas along the spinal column is felt to be warranted only in large tumors with infiltrative growth, whereas in the remaining cases other methods of treatment are considered to be more rational. In facial localization of hemangiomas a policy of expectation is not recommended. Low-voltage x-ray therapy should be performed in early terms of a child's life. (auth)

18007 STATE OF THE LUNG IN IRRADIATION OF THE CHEST IN PATIENTS WITH CANCER OF THE MAMMARY GLAND. Rabinovich, R. M.; Kantin, A. V. (Central Research Roentgeno-Radiological Inst., Leningrad). Vop. Onkol.; 17: No. 9, 20-9(1971). (In Russian).

In different periods of postradiation therapy, the state of the lung in 484 females having tumor affection of the mammary gland was investigated. After irradiation, damage of the lung was noted in 41.1% of the cases. The highest incidence of radiation pneumonias was found in patients treated with x rays and their combination with gamma radiation of radioactive cobalt. The least incidence (20.3%) of radiation pneumonias occurred in patients treated only with gamma rays of radioactive cobalt. The frequency and character of radiation injuries of the lung was determined by the amount of the exposure dose of irradiation, the method of radiation therapy, and the state of the lung at the time of radiation therapy. (auth)

18008 REGRESSION ANALYSIS ON THE MORTALITY OF THE HIROSHIMA ATOMIC BOMB SURVIVORS. Watanabe, Mineo (Hiroshima Univ.). Hiroshima J. Med. Sci.; 19: No. 2-3, 119-23(Sep 1970).

The author reanalyzed the data presented in the paper "Mortality Among A-bomb Survivors Based on the 1946 Survey." Regression analysis was conducted under the implicit condition that the mortality rate of each stratum has the weight of unity, because the author could not obtain the details of the numbers of the population from the original authors. The regression of the mortality rates to the age at bombing and the dose of exposed radiation from the atomic bombing are highly significant both in males and females and in any observation period. The term of the square of age at bombing improved the regression fairly well in females but not in males. The contributions of the term of the exposed radiation doses to the mortality rates, defined as the ratios of the sum of squares of deviations to the total sum of squares, are varied with the change of the period of observation. In the earlier period after bombing, the amounts of contribution of the radiation were fairly large but they became smaller in the third observation period. (auth)

18009 STUDIES OF THE MORTALITY OF A-BOMB SURVIVORS. 4. MORTALITY AND RADIATION DOSE, 1950–1966.

Beebe, Gilbert W.; Kato, Hiroo; Land, Charles E. Radiat. Res.; 48: No. 3, 613-49(Dec 1971).

The new (T-65) dose estimates are used to examine the mortality of 82,300 A-bomb survivors at Hiroshima and Nagasaki from 1950 to 1966 for evidence of dose-related effects of ionizing radiation, with attention to age, sex, city of exposure, calendar time, and cause of death. The reason for the previously reported excess mortality from cancer and certain other diseases in 1950 to 1954 is not further clarified. Thereafter, and apart from leukemia, and possibly also diseases of the blood and blood-forming organs, there is very little evidence of a dose-dependent increase in mortality until 1962–1966, when the evidence, by no means conclusive, suggests a more general carcinogenic effect. Examination of mortality from all natural causes except malignant neoplasms provides no support for the hypothesis that atomic radiation accelerates nonspecific aging in man. Through 1966, at least, excess mortality seen in the A-bomb survivors seems best explained in terms of disease-specific effects, especially leukemogenesis and, more generally, carcinogenesis. (auth)

18010 PROTECTIVE EFFECT OF ADRENOCHROME MONOGUANYLHYDROZONE METHANSULFONATE (S-ADCHNON) ON THE HEMATOPOIETIC ORGAN AS REVEALED IN IRRADIATED CANCER PATIENTS. Yamashita, Hisao; Okura, Jotaro; Izumi, Koichi (Keio Univ., Tokyo). J. Radiat. Res.; 12: No. 2, 41-50(Jun 1971).

Adrenochrome monoguanylhydrozone methanesulfonate (S-Adchnon) has the highest solubility in water among adrenochrome derivatives. From the action of S-Adchnon against capillaries, protective effect against radiation-induced damages of hematopoietic organs is to be considered. A dose of 100 to 300 mg of S-Adchnon was given 15 to 30 min before every expected irradiation by single intravenous injection, or it was administered in divided doses orally during the course of radiation therapy of cancer patients. A total of 150 cases treated by S-Adchnon were compared with 100 control cases receiving no protective agent. Variation of erythrocyte counts and hemoglobin contents was less than 5% in either S-Adchnon cases or control cases. The mean rate of reduction of leucocyte counts was 22 ± 4% in S-Adchnon-administered cases compared with 30 ± 4% in control cases indicating considerable effect of the drug. The mean rate of reduction of thrombocyte counts was 27 ± 3% in S-Adchnon administered cases and 40 ± 9% in control cases. This difference was also statistically significant. S-Adchnon was considered as one of the effective agents to reduce the side effect of radiation therapy on hematopoietic organ. (auth)

18011 RADIATSIONNAYA KARDIOLOGIYA. (Radiation Cardiology). Vorob'ev, E. I. Moscow; Atomizdat (1971). 272p.

An extensive survey was made of Russian and foreign literature on the action of ionizing radiation on the heart-vascular system and the processes involved in its recovery. Data on whole-body and localized irradiation, single and multiple dose, and various doses and dose rates are summarized. Immediate radiation effects and those manifest some time after exposure are compared. An evaluation of the radiosensitivity of the heart-vascular system is made on the basis of extended experimental studies on animals and clinical observations on men. (648 references) (tr-auth)

18012 PROGRESS IN RADIATION PROTECTION. Synopsis of 10 Years of Research. Braun, Heribert; Heuck, Friedrich; Ladner, Hans-Adolf; Messerschmidt, Otfried; Rausch, Ludwig (eds.). Strahlenschutz Forsch. Prax.; 10: 1-259(1970). (In German).

This collection of 16 articles by different authors discusses the various aspects of radiation injury to both humans and experimental animals. The possibilities of developing a pharmacopoeia of radioactive available and tested labeled compounds, chiefly for the selective internal radiation treatment of cancer, are explored. Radiation carcinogenesis, genetic damage, and embryonic and fetal radiation injury are the subjects of several chapters. Dosimetry, x ray diagnosis, radiation therapy, and medical aspects of radiation protection, including decontamination and radioactive waste handling, constitute the final topics of the book. (240 references) (K.S.W.)

18013 PREVENTION OF RADIATION SICKNESS. REPORT OF A DOUBLE BLIND RANDOM CLINICAL TRIAL USING PROCHLORPERAZINE AND METOPIMAZINE. Berry, G. H.; Duncan, W.; Bowman, Carol M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Clin. Radiol.; 22: No. 4, 534-7(Oct 1971).

A double-blind random trial is described that compares the efficiency of two anti-emetic agents and an inert substance in preventing nausea and vomiting after deep x-ray therapy. No significant difference was found in the incidence of radiation sickness or its duration when Prochlorperazine (30 mgm daily), Metopimazine (7.5 mgm daily) or an inert substance was given before, and for 3 days following, single x-ray treatments by two standard techniques. There was a significant difference in the incidence of radiation sickness and its duration in the two x-ray treatments. (auth)

18014 CHEMICAL PROPHYLACTICS FOR RADIATION SICKNESS. Shashkov, V. S.; Anisimov, B. V.; Saksonov, P. P. Probl. Kosm. Biol.; 14: 86-102(1971). (In Russian).

This survey considers the basic groups of chemical radioprotectors, the effectiveness of their combined use, and possible mechanisms of action for chemical radioprotectors (radical inactivation, physicochemical changes in molecules of the biosubstrate, oxygen effect, influence on metabolic processes, and recovery processes). (42 references) (JPRS)

18015 RADIATION INJURY OF THE SKIN AND SOFT TISSUES FROM SOURCES OF IONIZING RADIATION. Sosnovskii, A. T.; Karas, A. V. Zdravookhr. Beloruss.; No. 3, 38-41(1970). (In Russian).

A total of 51 patients with radiation injuries were studied, of which eight were medical and technical personnel who were directly involved with ionizing radiation in their respective occupations. About half (26) were afflicted with non-tumorous growths or benign tumors, and malignant tumors accounted for the remainder (17 cases). A numerical analysis is made of early and late ulcerous conditions, dermatitis, and a discussion of possible correlations with radiation dose is offered. (K.S.W.)

18016 CLINICAL AND GENETIC ASPECTS OF STUDIES OF SEX CHROMATIN IN DIFFERENT HUMAN POPULATIONS. Verkhovskaya, I. N.; Borodkin, P. A. Tsitol. Genet.; 5: No. 4, 296-7(Jul-Aug 1971). (In Russian).

Sex chromatin was studied in oral mucosa cells of 1543 persons who were born in an area with an elevated level of natural background radiation, as well as in those of pupils from an auxiliary school (294 persons), and psychochronic patients (104 persons). Persons with anomalous sex chromatin were detected only among children with an underdeveloped intellect (5 persons or 1.7%) and psychochronic invalids (2 persons or 2%). (auth)

18017 LESIONS OF THE BRACHIAL PLEXUS FOLLOWING RADIOTHERAPY OF BREAST CANCER. Steiner, C.; Fallet, G. H.; Moody, J.-F.; (and others). Schweiz. Med. Wochensch.; 101: No. 50, 1846-8(18 Dec 1971). (In French).

Nerve damage to the homolateral brachial plexus is reported in 23 patients treated post- or pre-operatively for breast cancer by the use of telecobalt or roentgen therapy. The clinical nature of the damage was assessed and an attempt made to establish the site and extent of the lesion by clinical neurological examinations and electrophysiological investigations. The features and evolution of the neurological syndromes of our patients resemble those reported in the literature. Post-radiation fibrosis or local metastases are the two most likely causes of this syndrome. In reviewing the case reported in the literature and examining the criteria that were suggested for diagnosis, we concur that biopsy examination in the course of surgical exploration of the plexus is the most reliable means of establishing a diagnosis. Of the 23 patients followed, seven have undergone surgical exploration with neurolysis. Biopsies in six of the seven cases revealed perineural fibrous tissue. In only one case did we find evidence of metastatic infiltration of the brachial plexus. In order to reduce the risk of nerve damage in patients treated for breast cancer, we deem it important to avoid cross-fire radiotherapy. If performed early, surgical intervention may give relief and allow a diagnosis to be made. (auth)

18018 EFFECT OF BREMSSTRAHLUNG RADIATION EMITTED BY 25 MeV BETATRON ON THE ACTIVITY OF NONSPECIFIC PHOSPHATASES IN THE SKIN. Savchenko, E. D.; Osipenkova-Vichtomova, T. K. (Scientific-Research Rentgeno-Radiological Inst., Moscow). Arkh. Patol.; 33: No. 11, 28-32 (1971). (In Russian).

Acid and alkaline phosphatases were studied in the skin of 22 betatron (25 MeV) treated patients with malignant tumors. A single dose was 300 rad while the total integral dose was 3,000 to 12,000 rad administered during 3 to 8 weeks. Following radiation therapy, histochemical studies were conducted throughout periods varying from several days to four yrs and a half. The data obtained evidence that the dose of 1200 to 7000 to 8000 rad

enhances to a greater or lesser degree the activity of alkaline and acid phosphatases. The most marked enhancement of enzymatic activity was recorded following administration of doses 6000 to 7000 rad which appear to have disturbed differentiation of cells and augmented their proliferation. Administration of the dose 10,000 to 12,000 rad abruptly and for a long time inhibits enzymatic activity in epithelial cells. (auth)

18019 PELVIC EXENTERATION FOR LATE SECOND CANCERS OF THE UTERINE CERVIC AFTER EARLIER IRRADIATION. Deckers, P. J.; Sugarbaker, E. V.; Pilch, Y. H.; Ketcham, A. S. (National Institutes of Health, Bethesda, Md.). Ann. Surg.; 175: No. 1, 48-54(Jan 1972).

Eighteen cases of late second cancers of the uterine cervix occurring 7 to 20 yrs after irradiation to an epidermoid carcinoma of this organ are reported. In 17 cases, the histology of the second tumor was similar to the early cancer. One patient developed a sarcoma of the cervix 14 yrs after initial irradiation. Although these patients complained of symptoms for only a short time, these second tumors were generally large and locally destructive, and behave in a very aggressive manner. All patients were treated by pelvic exenteration. A 35% 5-yr actuarial survival, free of disease or significant complications, was achieved. Six in-hospital fatalities occurred, which is indicative of the complications that can occur after extensive surgery involving previously irradiated pelvic structures. Pulmonary metastases developed in five patients and two patients who developed local recurrence also demonstrated visceral metastases simultaneously. The only patient living after 5 yrs at the time of the report had the sarcoma. The longest survivor among the 17 with carcinoma lived 7 yrs. (auth)

18020 RADIOLOGIC PRACTICE SINCE THE ATOMIC BOMBS: HIROSHIMA AND NAGASAKI. Sawada, Shozo (Hiroshima Univ.); Wakabayashi, Toshiro; Takeshita, Kenji; Yoshinaga, Haruma; Russell, Walter J. Amer. J. Public Health; 61: No. 12, 2455-68(Dec 1971).

From a study of records of community hospitals and clinics in Hiroshima and Nagasaki, the frequency of use of medical x ray from World War II to 1963 was determined according to films used, and radiographic, fluoroscopic, and photofluorographic examinations performed. A steady increase in use of medical x ray over the years was demonstrated for both cities and for all modes, except fluoroscopy in Hiroshima. The resulting data will facilitate estimation of average cumulative dose from medical x ray procedures since World War II in Hiroshima and Nagasaki. The methodology developed in this study may have useful application in other investigations of epidemiologic nature. (auth)

18021 RADIATION EXPOSURE TO THE USER ARISING FROM WORK WITH GENERATOR-PRODUCED RADIOISOTOPES. Trott, N. G.; Lillicrap, S. C. (Royal Marsden Hospital and Inst. of Cancer Research, Sutton, Eng.). pp 29-38 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

The significance of the increased use of short-lived radionuclides produced from generators is discussed; some general comparisons are made between the exposure of staff that may arise from the applications of these radionuclides and the established therapeutic techniques. Some data are presented on the effectiveness of shielding syringes during manipulation of ^{99m}Tc, ^{113m}In, and other radionuclides. A detailed analysis is given of the exposure, measured by TLD and film methods, of staff dealing with short-lived radionuclides in the laboratory and the clinic. It is shown that for laboratory staff dealing with several hundred millicuries of generator-produced ^{99m}Tc and some other nuclides per month, the mean annual exposure of the hands and of the whole body can be maintained at levels much less than the maximum permissible. However, increased use of radionuclides such as ^{87m}Sr or ^{113m}In may increase the problem because of the greater thickness of lead needed to provide adequate shielding of the more energetic γ that they emit. (auth)

Vertebrates

Refer also to abstracts 17932, 17943, 17953, and 17957.

18022 (AD-731091) EFFECT OF 6-MeV X-RAYS ON PLASMA-REDUCING SUBSTANCES IN THE PRIMATE (MACACA MULATTA). Final Report, October 1970-March 1971. Beckman, Fred N.; Craig, Dan J.; Nathan, Marc A.; Kinsley, Earl L. (School of Aerospace Medicine, Brooks AFB, Tex.). Aug 1971. 16p. (SAM-TR-71-28). NTIS.

Altered mammalian blood glucose levels following whole-body exposure to ionizing radiation have been well documented in the literature. Studies in the rat, guinea pig, and rabbit indicate that hyperglycemia follows irradiation after a period of hours to days. In contrast, in the primate, authors have reported either no response to ionizing radiation or an early glucose burst. Experiments were therefore undertaken that demonstrate: an early rise (30 to 50 mg %) of plasma-reducing substances within 14 min after the onset of 165 rads/min of 6 MeV x irradiation; and blockage of this rise by diphenydramine and alpha-chloralose. It is postulated that the early hyperglycemic response observed in the primate is much more closely related to the cardiovascular changes that occur immediately following ionizing radiation exposure than they are to gluconeogenesis and glycogenesis. (auth) (USGRDR)

18023 CHANGES OF THE VITAMIN C CONTENT OF THE ADRENALS OF X-IRRADIATED WHITE RATS. Kovacs, V. Stud. Univ. Babes-Bolyai, Ser. Biol.; 16: No. 1, 147-50(1971). (In Rumanian).

The modifications of the vitamin C content of the adrenals of white rats to which 200 R and 800 R x-ray doses were given were studied. The quantity of ascorbic acid was shown to be slightly decreased 24 hrs after irradiation compared to the control batches irradiated with 200 R and 800 R doses, this value being even higher in the case of the batch irradiated with 500 R. The variations in ascorbic acid content in the adrenals of x-irradiated rats are considered to be a sign of the organism restoring its resistence from the Syndrome of General Adaptation. (Rom. Sci. Abstr.) (auth)

18024 EFFECTS OF THE JRR-1 IRRADIATION ON REPRODUCTIVE FUNCTION OF THE MOUSE. 1. EFFECTS OF THE IRRADIATION ON BODY WEIGHT AND INTERNAL GLAND WEIGHT OF ADULT MALE MOUSE. Tanaka, Ryoichi; Kashiwabara, Takao (Ibaraki Univ., Japan). Nippon Chikusan Gakkai-Ho; 42: No. 2, 96-102(Feb 1971). (In Japanese).

Body weight and weights of testes, hypophysis, and adrenal of adult male mice were investigated under conditions of pile irradiation with 40 kw thermal neutrons and target skin distance of 20 cm in No. 7 hole of JRR-1, Japan Research Reactor No. 1 of Japan Atomic Energy Research Institute, and three exposure times of 1, 2, and 3.5 hrs. Large differences were not observed in the body weight curves among the 1 and 3.5 hr group and control, but those for the 2 hr group diminished more than other groups. In the 3.5 hr group, two mice that were irradiated in the closest cages to the source died within 30 days after irradiation, but from the 30th to 100th day, no mortality was observed. In the 2 hr group, two mice died between the 30th and 100th day after irradiation. Accordingly, the 2 hr group was more sensitive than the 3.5 hr group to the lethal effects of the irradiation. This unexpected result seems to be due to the fact that the raising season of the 3.5 hr group was more favourable than that of the 2 hr group. Time of exposure of total body to the JRR-1 irradiation, which is required to kill 50% of adult mice within 30 days after the irradiation, was about 2 hrs in the cage nearest to the source in the No. 7 hole. Dosage of the 2 hr exposure is presumed to be 7.2 to 36.0×10^{10} n/cm^2 neutron flux density and 400 to 800 R γ ray. The weight of testes decreased in long term raising after the irradiation. The hypophysis showed no change in weight, but the adrenals weighed more than the control. (Japan)

18025 EFFECTS OF THE JRR-1 IRRADIATION ON REPRODUCTIVE FUNCTION OF THE MOUSE. 2. EFFECTS OF THE IRRADIATION ON FERTILITY OF MALE MOUSE. Tanaka, Ryoichi; Kashiwabara, Takao (Ibaraki Univ., Japan). Nippon Chikusan Gakkai-Ho; 42: No. 3, 125-9(Mar 1971). (In Japanese).

Ds-strain adult male mice were irradiated for 1 hr and 3.5 hrs in No. 7 hole of JRR-1. Each of the treated male mice was mated individually to an adult nulliparous fertile female, and after they were raised in the same cage for 10 days or 15 days, each male mouse was mated again to another nulliparous female. This mating schedule was continued for 120 days after irradiation in the 1 hr group and 100 days in the 3.5 hr group. Regarding the female mice that were separated from the treated male mice, occurrence of parturition, litter size, number of stillbirths, and sex distinction were recorded. Fertility of the treated male mice decreased continuously during this mating schedule, however, a temporary sterile period did not appear in either group. Rate of parturition of the female mice mated with irradiated male mice differed with elapsed days after irradiation. The fertility of the 3.5 hr group was lower than that of the 1 hr group. The litter size of the 1 hr

group was smaller than that of the control from the 26th to 60th day after irradiation, but that of the 3.5 hr group was always smaller than that of the control. It was considered that a dominant lethal effect was induced in spermatozoa of the 1 hr group and in all germ cells of the 3.5 hr group by pile irradiation. There was no relation between litter size and stillbirth, and sex ratio of births showed no variation. (Japan)

18026 RADIOSENSITIVITY EFFECT OF MECYTOSINE ON EHRLICH TUMOR. Aleksandrov, S. N.; Vershinina, S. F. (Central Research Roentgeno-Radiological Inst., Leningrad). Vop. Onkol.; 17: No. 9, 88-91(1971). (In Russian).

A radiosensitizing effect of mecytosine (2-amino-4-methyl-6-oxypyrimidine) in a single dose of 100 mg/Kg daily was studied on 448 nonpedigree mice with ascitic and solid variants of Ehrlich tumor. The experiments were carried out in three variants: intraabdominal transplantation and total irradiation with a dose of 1500 R with subsequent transplantation immediately after irradiation; local single irradiation in doses of 616 and 735 R; and fractional local irradiation (1250 × 3). A marked radiosensitizing action of mecytosine was noted in all these cases. (auth)

18027 PRODUCTION OF LEUKOCYTAL INTERFERON IN IRRADIATED AND INTACT DOGS. Kamalyan, L. A.; Engoyan, M. N.; Vartevanyan, Zh. Ts. Vop. Virusol.; No. 5, 552-5(1971). (In Russian).

The interferon-synthesizing function of leukocytes was studied in intact and irradiated dogs under optimal experimental conditions. Newcastle disease virus, "A" strain was used as interferon inducer. Total single roentgen irradiation in a dose of 400 R produced in the majority of the dogs definite inhibition of interferon titers at 2 and 7 days of radiation disease; however, interferon preparations obtained from irradiated and nonirradiated animals had identical properties. Prolonged inhibition of interferon production was observed in animals dying of radiation disease, and stable titers of interferon in dogs with mild radiation syndrome. (auth)

18028 BEHAVIOR AND PHYSIOLOGY OF THE MONKEY (MACACA MULATTA) FOLLOWING 2500 RADS OF PULSED MIXED GAMMA-NEUTRON RADIATION. Turbyfill, C. L.; Roudon, R. M.; Kieffer, V. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Aerosp. Med.; 43: No. 1, 41-5 (Jan 1972).

Six monkeys, trained for a shock motivated visual discrimination task, and surgically implanted to monitor aortic and venous pressures, carotid flow, heart rate, and respiratory rate were irradiated with a 2500-rad (MTD) dose of mixed gamma-neutron radiation. One animal showed no performance decrement and one animal showed complete performance decrement within a few minutes following irradiation. Animals displaying performance decrements suffered an acute decrease in aortic pressure. The first physiological indication of the ensuing incapacitation period was a rapid fall of diastolic pressure followed by a decrease in systolic pressure. A second behavioral decrement was observed in five of the six animals at approximately 40 to 45 min postirradiation. The respiratory rate was in general significantly increased following irradiation. No significant changes were observed in carotid flow or venous pressure. (auth)

18029 AUTORADIOGRAPHIC STUDIES ON ^{14}C-LEUCINE INCORPORATION INTO MOTOR NEURONS OF THE SPINAL CORD OF X-IRRADIATED MICE. Olkowski, Zbigniew (Emory Univ., Atlanta). Amer. J. Anat.; 132: No. 3, 393-400(Nov 1971).

The incorporation of ^{14}C-leucine into the cytoplasm and nuclei of the motor neurons in the spinal cords of control mice and of mice given whole-body x irradiation was studied with the use of autoradiography. A decrease in isotope incorporation into the cell cytoplasm of the motor neurons in the spinal cords of irradiated mice was observed. The incorporation of ^{14}C-leucine into the nuclei of the motor neurons of spinal cords of irradiated animals was increased significantly as compared to the appropriate control values. (auth)

18030 AGE RESPONSES TO X RAYS, VINCA ALKALOIDS, AND HYDROXYUREA OF MURINE LYMPHOMA CELLS SYNCHRONIZED IN VIVO. Madoc-Jones, H.; Mauro, F. (Washington Univ., St. Louis). J. Nat. Cancer Inst.; 45: No. 6, 1131-43(Dec 1970).

A method is described for the induction of partial synchrony by means of hydroxyurea in a population of murine lymphoma cells in vivo. Three hours after lymphoma-bearing animals were each given a single intraperitoneal injection of hydroxyurea, the survival of femoral lymphoma colony-forming cells, as measured by the spleen-colony technique, was reduced to a plateau level of about 20%. The drug disappeared from both plasma and femoral marrow fluid between 3 and 4 hours after injection. The lymphoma cells surviving this treatment comprised a partially synchronized population. With this synchronization method, the survival of lymphoma cells treated, in different phases of the generation cycle in vivo, to x rays (374,562, or 740 rads), vinblastine (1 mg/mouse, 3-hour exposure) vincristine (0.33 mg/mouse, 3-hour exposure) or hydroxyurea (a second challenge; 5 mg/mouse, 3-hour exposure) was determined. The lymphoma cells showed a peak in sensitivity to x rays at the G_1/S transition and then grew more radioresistant as they passed through the S phase of the cell cycle. They had a maximal sensitivity to the two Vinca alkaloids as well as to hydroxyurea, when treated in the S phase. These age responses were similar to those of Chinese hamster or HeLa cells in vitro. The age response to x rays was analyzed in terms of variations in dose-survival curve parameters through the cycle; in addition, dose-fractionation studies indicated repair of sublethal damage at certain positions in the cell cycle. (auth)

18031 DELAYED LIQUID REPLACEMENT THERAPY FOR COMBINED THERMAL AND RADIATION INJURY. Novak, Janos. Honvedorvos; 23: No. 2, 123-33(Apr-Jun 1971). (In Hungarian).

In the case of a combined ionizing radiation-thermal burn inflicted on experimental animals, the mortality depended to a considerable extent on the irradiation sequence; for the order thermal injury–radiation injury a lower mortality resulted. For the experimental model of dual injury employed, the use of Prednisolone on the first post-traumatic day significantly improved the survival rate despite the delay in adequate infusion therapy (replenishment of liquid). (tr-auth)

18032 LUNG CONNECTIVE TISSUE MEASUREMENTS. I. AMINO ACID ANALYSIS PROCEDURES FOR DETERMINATION OF CANINE LUNG CONNECTIVE TISSUE. Pickrell, John A.; Shafer, Janette (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Arch. Intern. Med.; 127: 891-5(May 1971).

In order to better understand the pathogenesis of radiation-induced pulmonary fibrosis, techniques were developed to identify and quantitate connective tissue components of canine lung in the normal and diseased state. Lung tissue hydrolysates from normal dogs were prepared and amino acids were quantitated by chromatographic elution using a modified amino acid analyzer and mechanical integration. These methods yielded good resolution and acceptable integration of hydroxyproline and hydroxylysine, indicators of collagen, and desmosine, the indicator of elastin. The ability to measure hydroxyproline, hydroxylysine, and desmosine and thus obtain a quantitative estimation of the connective tissue content of normal canine lung lends confidence to the use of the technique reported here for measuring increased levels of connective tissue associated with pulmonary fibrosis. (auth)

18033 REGENERATION OF LOCALLY IRRADIATED SALAMANDER LIMBS FOLLOWING SUPERFICIAL SKIN INCISIONS OR NERVE TRANSECTION. Conn, H.; Wessels, S.; Wallace, H. (Amherst Coll., Mass. Univ. of Birmingham, Eng.). J. Exp. Zool.; 178: No. 3, 359-68(Nov 1971).

It is well known that prior local irradiation inhibits the ability of larval salamanders to regenerate an amputated limb, and that implantation of various non-irradiated tissues at the site of amputation restores this ability. Neither wounds in the irradiated region, nor wounds in the non-irradiated shoulder, promote regeneration. A superficial slit in the skin stretching from non-irradiated tissue to the irradiated site of amputation, however, restores the ability to regenerate. It is presumed that non-irradiated cells migrate down the slit during wound-healing and are thus present at the site of amputation and stimulate regeneration. Transection of the nerve roots following local irradiation of the limb permits a regrowth of non-irradiated axons into the irradiated limb. Such limbs recover both sensory and motor co-ordination and the ability to regenerate. Non-irradiated sections of nervous tracts (axons, Schwann cells, and connective tissue sheaths) also promote regeneration when transplanted into irradiated limbs. Since a nerve supply is almost always needed for limb regeneration, yet an irradiated nerve is sufficient for this purpose, no special sensitivity of nerves to x-rays is implied by these experiments. The normal function, regrowth, and trophic effects of axons appear to be unimpaired by exposing the entire neuron to doses of irradiation that inhibit limb regeneration. (auth)

18034 OBSERVATIONS ON THE PHARMACOLOGY OF BARBITURATES IN MONKEYS (MACACA MULATTA) EXPOSED TO GAMMA-NEUTRON RADIATIONS. Davis, Lawrence W.; Brown, James A.; Strike, Thomas A. (Armed Forces Radiobio-

logy Research Inst., Bethesda, Md.). Res. Commun. Chem. Pathol. Pharmacol.; 2: No. 4-5, 447-60(Jul-Sep 1971).

The plasma disappearance half-times of barbital, hexobarbital, and pentobarbital, and the plasma and cerebrospinal fluid disappearance half-times of pentobarbital-^{14}C were determined in monkeys. These half-time values were compared to the ones obtained after the monkeys received 1500-, 5000-, or 10,000-rad doses of mixed gamma-neutron radiations to the entire body. In general, a radiation dose dependent increase of plasma disappearance half-times for all drugs was evident with a significant increase for barbital after 5000 rads ($P < .001$) and hexobarbital after 10,000 rads ($P < .05$). Cerebrospinal fluid disappearance half-time of pentobarbital was significantly prolonged in the monkeys receiving 5000 rads. These results are interpreted as indicating that increased barbiturate effectiveness is related to decreased renal excretion of the drug, decreased drug metabolism by liver enzymes, and increased drug concentration in the central nervous system. (auth)

18035 RADIATION RECOVERY OF LONG-LIVED LYMPHOCYTES IN THE RAT. Benninghoff, D. L; Girardet, R.; Stackhouse, L. (State Univ. of New York, Brooklyn). Radiat. Res.; 48: No. 3, 589-98(Dec 1971).

Rats were given 300 rads total body irradiation and the recovery time of the long-lived lymphocyte pool was determined. The mobilizable lymphocyte pool was measured by thoracic duct lymphocyte drainage. The cell content of the superficial cervical and mesenteric lymph nodes was also determined. Additionally, the transformation response of thoracic duct lymphocytes to pokeweed mitogen was tested to assess the recovery of immunologic competence of the irradiated animals. It was found that the lymphocyte pool was in process of recovery at one month and completely recovered by two and three months after 300 rads total body irradiation. The transformation response of the thoracic duct lymphocytes of animals was tested after irradiation and was equal to that of unirradiated control animals. The slow recovery of the lymphocyte pool, which is thought to involve a two-step bone marrow-thymus pathway of reconstituting cells, is consistent with the normal kinetics of the long-lived lymphocyte pool. (auth)

18036 EFFECTS OF RADIATION ON THE MITOTIC RATE IN THE UTERINE AND VAGINAL EPITHELIA IN OVARIECTOMIZED MICE TREATED WITH ESTRADIOL. Mori, Takao; Matsumoto, Akira; Egami, Nobuo (Tokyo Univ.). Proc. Jap. Acad.; 47: No. 4, 401-6(Apr 1971).

A study was carried out using six groups of female mice of C57 Black/Tw strain ovariectomized at 50 to 60 days of age. A single subcutaneous injection of 10 μg estradiol-17β dissolved in 0.1 ml sesame oil was given to mice in five groups while 0.1 ml sesame oil was given to the remaining group as control. Animals in four out of five estradiol-injected groups were subjected to whole-body irradiation with 500 R of x rays at intervals of 1, 3, 6, and 9 hrs. The x-ray generator (Toshiba KCX-18) was operated at 25 mA, 170 KV with 0.5 mm Cu and 0.5 mm Al filters, the exposure rate in air being approximately 30 R/min. The mitotic figures in both vaginal and uterine epithelia disappeared almost completely within one month of ovariectomy. Estradiol injection proved to result in marked rise in the mitotic rate of the cell population of the epithelia in the ovariectomized mice within 30 hrs. Irradiation one hour after estradiol injection was followed by a marked drop in the mitotic activity in both epithelia 30 hrs later. Irradiation at 3, 6, and 9 hrs after estradiol administration led to a decrease in the mitotic rate in approximately the same degree in the vaginal epithelium, while the mitotic rate in the uterine epithelium varied significantly according to the length of the interval between estradiol administration and irradiation. (Japan)

18037 MORPHOLOGICAL STUDIES ON THE EFFECTS OF IRRADIATION FROM A 15 MeV BETATRON ON THE FUNCTION OF THE ADRENAL CORTEX OF ALBINO RATS. Kunishige, Tsuneyuki (Yamaguchi Univ., Ube, Japan). Yamaguchi Igaku; 18: No. 3-4, 215-27(Dec 1969). (In Japanese).

Albino rats were given whole-body irradiation of 250, 500, or 1000 R, using a 15-MeV Betatron x radiation or ^{60}Co γ rays from the Telecobalt apparatus. The rats were killed 4 hr or 1, 3, 6, 10, or 15 days later and the effect of irradiation on adrenal cortex was examined through adrenal weight, thickness of the layers of adrenal cortex, Hematoxylin-Eosin and Sudan III staining, Plasmal reaction, and ascorbic acid staining. Adrenal weight did not show marked change following irradiation of 250 R from the Betatron or from ^{60}Co, but the rats given 1000 R from the Betatron all died on the 10th day and those given 1000 R from ^{60}Co all died on the 6th day after irradiation. The thickness of the adrenal cortex did not show much change in the zona glomerulosa and zona reticularis following irradiation with the Betatron or ^{60}Co, while the zona fasciculata became slightly thicker following 1000 R from the Betatron and ^{60}Co. Acidophilicity was lower in the zona fasciculata for 2 days after irradiation from the Betatron at all three doses. Mitosis was observed in a few cases for 3 to 15 days after irradiation at 250 and 500 R, and appeared in high incidence in the outer layer of the zona fasciculata after the 6th day. Regressive degeneration of the nucleus appeared strongly on the 6th day after irradiation at 1000 R. Acidophile granules, vacuolization and degeneration of cytoplasm, and mitosis produced by ^{60}Co irradiation appeared later than those by Betatron irradiation. Irradiation at 250 and 500 R from the Betatron produced greater change in the nucleus of cortex than that with ^{60}Co, but changes in the cytoplasm were weaker. The tissue recovered to normal 10 to 15 days after irradiation at 250 and 500 R from the Betatron but the tissue did not recover after irradiation with ^{60}Co, although there was no marked difference between these tissues in histochemical examination. It was thereby concluded that Betatron irradiation is more significant than ^{60}Co irradiation. (Japan)

18038 HISTOCYTOCHEMISTRY AND THE REGENERATIVE CAPACITY OF MUSCLE TISSUE AFTER EXPERIMENTAL DAMAGE IN WHITE RATS IRRADIATED IN UTERO. Kuc, Andrzej. Folia Morphol.; 30: No. 2, 279-88(1971). (In Polish).

Fifteen pregnant female white rats were irradiated with a single dose of 200 R to the whole body on the tenth and fifteenth days of pregnancy. In 88 offsprings the abdominal muscles were injured 10 weeks after birth, and the regenerative capacity of the muscle tissue was observed after 1 to 28 days. Sections were stained with Azan, and reactions were performed for RNA, glycogen, phosphorylase, acid and alkaline phosphatases and lipids. The observations showed that muscle tissue irradiated during embryonic development retains its regenerative capacity after birth of the animals. Disorders of regeneration were observed, however, consisting of intensification of degeneration in the damaged fibers, diminished number of regenerating fibers, and delayed formation of new muscle fibers. The disorders of regeneration were more pronounced in the group of animals irradiated in utero in the second half of pregnancy, i.e., in the period of histogenesis of muscle tissue in fetuses. (auth)

18039 ALTERATION OF THE CONCENTRATION OF SEROTONIN AND 5-OT-ORGANELLES IN RABBIT THROMBOCYTES IN ACUTE RADIATION SICKNESS. Dorofeev, V. M.; Nestaiko, G. V. (Inst. of Medical Radiology, Obninsk, USSR). Byull. Eksp. Biol. Med.; 72: No. 10, 21-4(Oct 1971). (In Russian).

Rabbits were irradiated with a total dose of 600 R of ^{60}Co gamma radiation administered at a rate of 140 R/min; a reduction occurred in the level of blood serotonin and in the number of thrombocytes. Electron microscope studies revealed a decreased number of serotonin-containing granules in the thrombocytes, a decreased quantity of thrombocyte sections containing 5-OT organelles, and a reduction in the number of sections containing 2,3 and 4 granules. Apparently, the decrease in the content of serotonin in the thrombocytes following irradiation was associated with an increase in the number of blood platelets with a low level of this amine. (auth)

18040 LATE EFFECTS OF IRRADIATION OF NEWBORN MICE WITH GAMMA RAYS. II. CHANGES IN PERIPHERAL BLOOD AND THE SIZE OF INTERNAL ORGANS. Gajewski, A. K.; Slowikowska, M. G.; Gryzmala, W. J. Rocz. Panstw. Zakl. Zakl. Hig.; 22: No. 2, 221-9(1971). (In Polish).

New-born mice of either sex of an inbred strain were randomly divided into eight experimental groups. The animals were irradiated with one of the following four doses of gamma rays: O R (control group), 150 R, 300 R, and 450 R. Observations of late effects of irradiation on the peripheral blood and on the size of internal organs were carried out on the 400th day after the experiment was started. It was found that irradiation of new-born mice caused a decrease in the hematocrit values, in the hemoglobin contents, and in erythrocyte and leucocyte counts. The weight of internal organs was distincly lower in the case of the irradiated animals than in the non-irradiated ones. The decrease in the weight of the majority of internal organs was proportional to the decrease of the body weight. Only the weight of the kidneys, in both males and females, and the weight of testes in males was decreased more than was the total body weight. (auth)

18041 INFLUENCE OF RADIOPROTECTORS ON THE REGENERATION OF THE MUCOSA OF THE SMALL INTESTINE OF MICE EXPOSED TO A LOW DOSE OF X-IRRADIATION. Maisin, J. R.; Lambiet-Collier, M. (CEN, Mol, Belgium). Int. J. Radiat. Biol.; 21: No. 1, 57-63(Jan 1972).

The response of the stem cells of the duodenal mucosa in mice

protected with 2-β-aminoethylisothiouronium-Br-HBr (AET) or with a mixture of (AET), mercaptoethylamine (MEA), glutathione (GSH), cysteine (cyst) and 5-hydroxytryptamine (5-HT) and exposed to 225 R of x-rays was studied. Under these conditions the protective action observed in the stem cells of the duodenum was partially masked by the biochemical shock that followed the administration of these chemicals. For the four end-points studied, a protective effect was observed only for the number of nuclei per crypt and the number of pycnotic and karyorrhectic nuclei. (auth) (UK)

18042 THRESHOLD DOSE VIEWED BY CURRENT THEORIES ON BIOLOGICAL EFFECTS OF IONIZING RADIATION. Sedlak, A. (Inst. of Radiation Hygiene, Prague). Cas. Lek. Cesk.; 110: No. 12, 278-81(19 Mar 1971). (In Czech).

A brief outline is presented of current theories on the lowest doses of radiation having an observable effect on biological materials, inducing radiation damage, i.e., the hit theory, the target theory, and Rossi's conception of local energy density. (NSA of Czech.)

18043 OSTEOBLASTIC REACTION OF THE BONE MARROW OF IRRADIATED MICE AND GUINEA PIGS. Shvets, V. N. (Inst. of Epidemiology and Microbiology, Moscow). Byull. Eksp. Biol. Med.; 72: No. 11, 113-16(Nov 1971). (In Russian).

F_1 (CBA × C57Bl) mice-hybrids and guinea pigs were subjected to whole-body x-ray irradiation. The number of osteoblasts in the myeloid cavity of the diaphysis of the femoral bone was calculated. A significant increase in the number of osteoblasts (by 2 to 5 times) towards the tenth day of irradiation in both species of animals and a reduction of the number of these cells towards the 20th day were noted. Between the 20th and 30th day the number of osteoblasts reached the level of these cells in intact animals. (auth)

18044 FREQUENCY OF CHROMOSOMAL ABERRATIONS IN THE BONE MARROW CELLS OF MONKEYS AT DIFFERENT POST-IRRADIATION PERIODS. Kosichenko, L. P.; Khashba, L. I. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Byull. Eksp. Biol. Med.; 72: No. 11, 104-6(Nov 1971). (In Russian).

Three months and 5 years after an acute gamma-irradiation in doses of 550 to 650 R the number of chromosome reconstructions in the bone marrow cells of apes was significantly in excess of control figures. The main type of structural breaks in chromosomes was acentric reconstructions. The number of chromosomal reconstructions in the examined apes after a lapse of 2, 6 and 8 years occurring in anaphases and telophases, though in excess of control figures, was not statistically significant. The late somatic effect of radiation was not related to the sex of the animals. (auth)

18045 PHOSPHATASES IN TESTES AND EPIDIDYMIDES OF ALBINO RATS AFTER PARTIAL BODY GAMMA-IRRADIATION. Gupta, G. S.; Bawa, S. R. (Punjab Univ. Chandigarh, India). J. Reprod. Fert.; 27: No. 3, 451-4(Dec 1971).

Thirty rats were irradiated with a single surface dose of 2000 R to the scrotum, (dose rate 70 to 80 R/min) from a ^{60}Co γ source. The phosphatase activity was estimated in the tissues, and the mean values after 7 and 15 days are tabulated, together with those of 25 controls. The activity of acid β-glycerphosphatase in the testes continuously decreased after 72 hr irradiation to 82% of the controls. On the 7th day there was a 32% decrease in the activity and on the 15th day the decrease was approximately 70%. In epididymus tissue, decrease in activity was not appreciable in the early stages. After 24 hr, inorganic pyrophosphatase activity was 80% in the testes and in the epididymides 85% of the controls. After 7 days, the activity in the testes was 32% and in the epididymides 54%. Similar, but less pronounced, effects were observed in the activity of alkaline phosphatase and glucose-6-phosphatase. (UK)

18046 THEORETICAL STUDIES OF THE DOSE-TIME-EFFECT RELATION IN RADIOBIOLOGY. Kaufmann, H. (Univ. Bochum, Essen). J. Belge Radiol.; 54: No. 4, 523-9 (1971). (In French).

To interpret the effect of the time factor, the author considers that a process of regeneration takes place simultaneously either between the irradiations (during fractionated treatment) or during irradiation in prolonged low-intensity treatment. In the present study, the author seeks to apply plausible mathematical models to these phenomena of regeneration and to compare quantitatively, with the aid of the models, the action of fractionated irradiation with that of a single irradiation. The differences between the models appear to be small and, practically speaking, it is sufficient to use a purely formal method of calculation, using an exponential law. (auth) (France)

18047 INDUCTION OF UNRESPONSIVENESS TO CANINE RENAL ALLOGRAFTS BY TOTAL IRRADIATION AND BONE MARROW TRANSPLANTATION. Rapaport, F. T. (New York Univ.); Cannon, F. D.; Blumenstock, D. A.; Watanabe, K.; Ferrebee, J. W. Nature (London) New Biol.; 235: No. 58, 190-2(9 Feb 1972).

A study was made of the survival of renal allografts obtained from the same donors in recipients selected genetically and serologically for DL-A antigen compatibility in a closely bred beagle colony. The animals received supra lethal whole body irradiation, (1,200 to 1,400 r of continuous radiation at a dose-rate of 3 to 4 r/min), followed by a bone marrow transplant before renal grafting. Bone marrow allografts without renal transplants were surviving without evidence of graft-versus-host disease from 124 to 349 days in 9 recipients from littermate donors. Three recipients of bone marrow obtained from non-littermate donors were surviving after 118, 179 and 180 days. Kidney allografts continued to function normally from 82 to 291 days in 9 pretreated littermate recipients and from 54 to 110 days in 3 non-littermate pretreated recipients. In 13 untreated littermates and nine untreated non-littermates, the renal transplants were rejected by the 45th post operative day. (UK)

18048 COMPARATIVE INVESTIGATION OF THE BIOLOGICAL ACTION OF DIFFERENT TYPES OF RADIATION: 660 MeV PROTONS, X- AND GAMMA-RAYS. Lavrov, B. A.; Filippov, Yu. M.; Yanovskaya, B. I. Byull. Eksp. Biol. Med.; 72: No. 10, 47-9(Oct 1971). (In Russian).

Studies were made of changes in the weight of the spleen and gonads, as well as the content of ascorbic acid in them and in the bone marrow after irradiation of rats with equal doses of x-rays and protons of 660 MeV–400 rad and gamma-rays and protons–600 rad. In comparison with x- and gamma-rays the relative biological activity of protons in respect to the spleen and bone marrow proved to be less than one unit and closer to one a unit for the action on gonads. Thus, gonads proved to be more sensitive to the effect of protons (660 MeV) than the spleen and bone marrow. (auth)

18049 INFLUENCE OF SUB-LETHAL IRRADIATION IN COCCIDIAL AND CAPILLARIA INFECTION IN THE HEN. Harisch, G.; Dey-Hazra, A.; Enigk, K.; Schole, J. (Tieraerztliche Hochschule, Hanover). Zentralbl. Veterinaermed., Reihe B.; 18: 527-33(1971). (In German).

The survival rate of chicks given a lethal dose of Eimeria necatrix oocysts 30 minutes after sub-lethal irradiation (200 or 400 R) was 100%. If the chicks were infected at other intervals after irradiation the survival rate was significantly lower. The level of Capillaria obsignata infection is significantly lower if chicks are infected 30 minutes after irradiation with 200 R. The glutathion quotient (SH glutathion/disulphide glutathion) reached its minimal value 30 minutes after irradiation and then rose to its maximum 60 minutes after irradiation. This maximum is also obtained, and even increased, if the animals are infected with Eimeria necatrix 30 minutes after irradiation. At this time after irradiation the infection coincides with the anti-regulatory (anabolic) phase of the alarm reaction. One hour after sub-lethal irradiation there seems to exist an endocrine status which markedly influences the effect of an infection. This model may thus be suitable for a more detailed study of the question of resistance. (auth)

18050 EFFECT OF RADIATION ON LYMPHOCYTES: ABOLITION OF THE PHENOMENON OF ALLOGENEIC STEM CELL INACTIVATION. Manyko, V. M. (Inst. of Biophysics, Moscow). Folia Biol. (Prague); 17: No. 6, 365-9(1971).

Transplantation of a mixture of hemopoietic and lymphoid cells of parental genotypes into lethally irradiated (CBA × C57BL)F_1 mice results in inactivation of the grafted stem elements. Under the influence of CBA lymphocytes the C57BL colony-forming units (CFU) do not proliferate. In vitro irradiation of lymphocytes abolished their ability to inactivate allogenic stem cells. The analysis of this phenomenon showed that this inactivating capacity of allogenic lymphocytes is significantly more radioresistant than the proliferative capacity of hemopoietic or lymphoid elements: the D_0 value for radiation-induced inactivation of this particular capacity of lymphocytes is 535 R and n = 1.08; the ranges of the D_0 value for proliferating hemopoietic or antibody-producing cells is 70 to 125 R, and n = 1.0 to 2.72. It was also established that the mean size of the non-inactivated colonies of hemopoietic cells increases with the irradiation dose for

lymphocytes. The experimental data permit the conclusion that the inactivation of allogenic CFU requires functional activity of lymphocytes, but not necessarily their proliferative capacity. (auth)

18051 OPPOSITE EFFECT OF ADRENALECTOMY UPON ERYTHROPOIETIC ACTIVITY IN THE SPLEEN AND IN THE BONE MARROW OF IRRADIATED MICE. Pospisil, M.; Zeman, P. (Inst. of Biophysics, Brno). Folia Biol. (Prague); 17: No. 6, 399-404(1971).

The effect of adrenalectomy on the erythropoietic activity in the spleen and in the femoral bone marrow was studied in mice after sublethal whole-body exposure to x rays by means of the radioactive iron uptake method. The results demonstrate an opposite manifestation of glucocorticoid insufficiency in the two murine erythropoietic organs in the course of postirradiation recovery. While the erythropoietic activity in the spleen was stimulated by adrenalectomy, an inhibition was found in the femoral bone marrow under the same conditions. Splenectomy did not affect the inhibitory action of adrenalectomy on bone marrow activity. The results of these experiments reveal a complex nature of the action of glucocorticoids on hemopoietic cell populations during recovery from radiation damage. The complexity is assumingly due to the intermingling of direct inhibitory effects of glucocorticoids on mitosis with the indirect consequences of metabolic disturbances. (auth)

18052 DIFFERENTIATION OF NEUROHYPOPHYSEAL PITUICYTES UNDER CONDITIONS OF THE WHOLE-BODY IRRADIATION. Voitkevich, A. A.; Dedov, V. I. (Research Inst. of Medicinal Radiology, Obninsk, USSR). Byull. Eksp. Biol. Med.; 72: No. 11, 107-9(Nov 1971). (In Russian).

The ultrastructural organization of the pituicyte cytoplasm develops progressively during the postnatal period and at the age of two weeks is fully developed. After whole-body irradiation of newborn rats the number of lipid inclusions in the pituicyte cytoplasm increased progressively with post-exposure time. Other changes noted were merging of individual inclusions, deformation of the nucleus, and reduction of organoids. Two weeks following irradiation cilia were observed in the cells and in the intercellular spaces. (H.L.W.)

18053 STEREOLOGICAL STUDY ON SIZE AND NUMBER OF MITOCHONDRIA IN ZONA FASCICULATA OF RAT ADRENAL CORTEX AFTER WHOLE-BODY X-IRRADIATION. Yogo, N.; Sekiyama, S.; Kurokawa, H.; (and others) (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol.; 21: No. 1, 1-10(Jan 1972).

The weight of the zona fasciculata in rat adrenal cortex increased to about 50% over the control during the period of 72 hours after whole-body x irradiation of 1000 R. The mitochondria of the parenchymal cells in the zona fasciculata were reconstructed three-dimensionally by Bach's theory on sphere-size distribution, using electron micrographs recorded at random during the post-irradiation period. The average volume of mitochondria was significantly larger than the control at 24 and 48 hours, but smaller at 72 hours after 1000 R. The total number of these mitochrondria in an individual rat decreased to 60% of the control at 24 hours and then increased to about twice the control at 72 hours. The size-distribution histograms showed that small mitochondria with radii shorter than 0.3 μ are practically absent in the control and in groups at 24 and 48 hours, but present in the rats at 72 hours. (auth) (UK)

18054 INTRAORGANIC BLOOD VESSELS OF THE CANINE PERITONEUM IN ACUTE RADIATION SICKNESS. Abdurakhmanov, F. A. (Dept. of Normal Anatomy, Dushanbe, USSR). Arkh. Anat., Gistol. Embriol.; 62: No. 1, 61-6(Jan 1972). (In Russian).

Dynamics of morphologic changes to the intraorganic blood vessels of the parietal and visceral peritoneum were studied in 33 dogs (10 of them serving as controls) after total irradiation with 1200 R, RUM-3 being used. Peritoneal blood vessels and capillaries were detected by injectional and injectionless methods. Comparative studies of the preparations have shown that during the 1st week after the irradiation in the peritoneum there occurred diffuse dilation and blood congestion in the organic vessels, in their venous links predominantly. Congestion was accompanied by a pronounced edema of the interstitial tissue and by a disturbance of the permeability of the vascular walls. On the 14 to 15th days after irradiation, certain disorders were found in the architectonics of the vascular and capillary network in the peritoneum. Emptification and lessening of the amount of blood capillaries was shown to take place as a result of their reduction and obliteration. Argentophilic and collagenous structures of the vessels underwent degenerative changes. (auth)

18055 EFFECT OF SOME ALKYLATING AGENTS AND THE WHOLE-BODY IONIZING IRRADIATION ON THE FORMATION AND REALIZATION OF THE IMMUNOLOGICAL MEMORY. Kazaryan, K. A.; Fontalin, L. N.; Pevnitskii, L. A.; Solov'ev, V. V. (Inst. of Epidemiology and Microbiology, Moscow). Byull. Eksp. Biol. Med.; 72: No. 11, 58-61(Nov 1971). (In Russian).

The secondary response in mice twice immunized with 1×10^6 sheep erythrocytes was studied by using the Jerne method. The animals were subjected to the action of alkylating compounds (sarcolysin, degranol, ThioTEPA, cyclophosphamide), or of γ-irradiation, either at the time of primary immunization, during revaccination, or in the interval between them. The agents under examination blocked the realization of immunological memory and weakened its formation. The alkylating compounds exercised a stronger influence on the process of the memory formation than on the already formed memory. An inverse regularity was characteristic of irradiation. The observed peculiarities are explained in relation to the concept of different sensitivity of the resting and proliferating lymphoid cells to irradiation and to alkylating compounds. (auth)

18056 ULTRAVIOLET PHOTOCHEMISTRY OF DNA IN MOUSE SPERMATOZOA. Meistrich, M. L.; Rauth, A. M. (Univ. of Toronto, Ontario Cancer Inst., Toronto). Mutat. Res.; 14: No. 1, 133-6(Jan 1972).

The uv photochemistry of DNA in mouse spermatozoa was studied. The spermatozoa were irradiated, hydrolyzed, and then chromatographed to determine the presence of thymine–thymine and thymine–cytosine dimers. For comparative purposes, DNA in mouse L cells and DNA in solution were also studied. The photochemistry of the DNA in mouse spermatozoa was indistinguishable from that of the other two sources. (E.R.B.)

18057 DEVELOPMENT OF THE PATHOLOGICAL PROCESS IN THE GASTROINTESTINAL TRACT IN CASES OF ENTERIC FORM OF ACUTE RADIATION SICKNESS. Lebedeva, G. A. Arkh. Patol.; 33: No. 11, 12-18(1971). (In Russian).

During general and local x irradiation in doses of 1000 to 1300 R, the depth of injury of different tissue systems of the gastrointestinal tract is determined by the intensity of cellular decomposition, the degree of suppression of mitotic division, and the longevity of life of the remaining cellular forms after irradiation. After using the modifications of irradiation, the most acute disorder emerges in the epithelium of the proximal part of the small intestine, where a great number of giant cells appear. These cells preserving their primitive covering function become incapable of carrying out some more complicated processes connected with digestion and absorption. The affection of the epithelial covering of the small intestine to a considerable degree determines the development of the intestinal syndrome and the death of animals in this form of radiation sickness. (auth)

18058 PATHOLOGIC ANATOMY OF THE INTESTINAL FORM OF ACUTE RADIATION SICKNESS IN DOGS. Shikhodyrov, V. V.; Lebedev, B. I. Arkh. Patol.; 33: No. 11, 18-22(1971). (In Russian).

Dogs irradiated with γ-neutrons in a dose of 1000 to 5000 Rem develop an acute intestinal syndrome with the fatal outcome on the 3rd to 7th day. The most significant changes of necrobiotic and gangrenous character occur in the proximal section of the small intestine. Morphological changes of other visceral organs are not so well pronounced to regard them as an immediate cause of the animals' death. Anatomically pathological pattern of the acute intestinal syndrome in general appears to be closely similar to that of manifestations due to the effect of the functional trauma. Analysis of the data obtained suggests a possible development in the terminal period of a secondary shock. (auth)

18059 PATHOGENESIS OF THE ENTERIC FORM OF THE ACUTE RADIATION SICKNESS. Gorizontov, P. D. Arkh. Patol.; 33: No. 11, 3-12(1971). (In Russian).

On the basis of the literary data and experimental investigations, the author gives the general characteristics of radiation sickness of the intestine. The author also discusses the problems of pathogenesis and the mechanism of death. He also touches upon the factors that lower or raise resistance to radiation of the enteric epithelium. On the basis of these materials the author gives a scheme of the pathogenetic action of the radiation in cases of the enteric form of acute radiation sickness. (auth)

18060 CATABOLISM OF PYRIMIDINE DEOXYRIBONUCLEOSIDES IN GOLDEN HAMSTER AFTER WHOLE-BODY

IRRADIATION. Buric, L.; Blazek, L.; Arient, M.; (and others) (Charles Univ., Prague). Int. J. Radiat. Biol.; 21: No. 1, 93-6(Jan 1972).

The excretion of deoxycytidine and deoxyuridine was followed for 24 hrs in the urine of golden hamsters non-irradiated or given 900 R at a dose rate of 13 R/min. The tabulated results showed the hamsters excreting twice as much deoxyuridine as deoxycytidine. After 900 R, the excretion of each compound was significantly increased (by about 35%) and their ratio was unchanged. The action of nucleoside aminohydrolase in the liver was not changed within the first 24 hrs after the irradiation. All irradiated hamsters died between 4 and 12 days after irradiation. (UK)

18061 CHANGES IN GLUTAMIC ACID AND GLUTAMINE METABOLISM IN THE RAT BRAIN AFTER WHOLE BODY X-IRRADIATION. Haulica, A.; Trandafirescu, M.; Ababei, L. (Inst. of Medicine, Iasi). J. Neurochem.; 18: 2447-50(1971).

After whole-body irradiation with x rays, an increase in the free ammonia concentration in the rat brain was observed. Parallel to this increase, evidence was found of a strong activation of glutaminase. Incubation increased the endogenous ammonia-forming capacity of brain homogenates to a much greater extent in irradiated rats than in normal rats. Glutamine synthetase activity decreased within the first 2 hr after irradiation but remained unchanged at 24 and 96 hr after irradiation. On the other hand, at 48 hr after irradiation, glutamate dehydrogenase activity in the brain had fallen by 75% in comparison with the initial activity. It is concluded that metabolic systems other than the glutamine–glutamic acid system contribute to the ammonia formation in the brain after irradiation. (auth)

18062 X-RAY INHIBITION OF GASTRIN-STIMULATED ACID SECRETION IN RELATION TO MUCOSAL ACTIVITY OF (Na^+, K^+)-DEPENDENT ATPASE. Vaughan, Burton E.; Cummins, Joseph T.; Pessotti, Rita L. (Battelle Memorial Inst., Richland, Wash.). Radiat. Res.; 48: No. 3, 508-17(Dec 1971).

Immediately after a dose of 240 R, whole-body x irradiation to rats, spontaneous (nonstimulated) acid secretion was inhibited. The inhibition was transient and acid secretion (pH 3.0) resumed promptly after injection of gastrin as the semipurified hormone. During the stimulation phase, a subsequent irradiation dose of 3000 R again inhibited secretion, but secretion resumed on cessation of irradiation. Four hours after x-ray exposures to 600 or 1200 R, a radiation dose-dependent reduction in acid secretion was demonstrated. This inhibition would be detected reliably only when acid secretion was maximally stimulated, 20 minutes after gastrin injection. Activity of the (Na^+, K^+)-dependent ATPase (Skou "transport enzyme") from gastric mucosa was unaffected by gastrin or irradiation treatments. For all treatments enzyme activity was 0.456 ± 0.014 (600 R), and 0.476 ± 0.017 μeq/minute/mg P (1200 R). Enzyme activity in other studies had been found to be radiation sensitive in this dose range. The findings indicate that irradiation acted at a neurological control level, to inhibit acid secretion, and probably with negligible consequences to the parietal cell. (auth)

18063 ULTRASTRUCTURAL FEATURES OF THE EARLY PROLIFERATING CELLS INVOLVED IN HEMOPOIETIC COLONY FORMATION. Degowin, Richard L.; Hoak, John C.; Miller, Suzanne H. (Univ. of Iowa, Iowa City). Radiat. Res.; 48: No. 3, 495-507(Dec 1971).

After flash labeling with tritiated thymidine for autoradiography, a cohort of early proliferating autologous hemopoietic cells was examined in endocolonized mouse spleens with light and electron microscopy. During the first three to five days postirradiation, proliferating cells within colonies resembled medium to large immature lymphocytes. A thin rim of nuclear chromatin on an irregular inner nuclear membrane characterized the early cells. After day 5, erythroblasts were readily detected. Although unirradiated spleens contained myeloid and erythroid precursors, cells resembling lymphocytes were most frequently seen. Spleens of mice, receiving lethal total-body x irradiation four days previously, contained very few cells synthesizing DNA and no erythroblasts. Macrophages ingesting nuclear material could be seen with light and electron microscopy. (auth)

18064 RESPONSE OF MOUSE JEJUNAL CRYPT CELLS TO LOW DOSE RATE IRRADIATION WITH CALIFORNIUM NEUTRONS OR RADIUM GAMMA-RAYS. Withers, H. Rodney; Oliver, George D. Jr.; Glenn, D. W. (Univ. of Texas, Houston). Radiat. Res.; 48: No. 3, 484-94(Dec 1971).

Californium-252 emits neutrons and gamma-rays and has a potential use in radiotherapy as a replacement for radium. There is no single value for the relative biological efficiency (RBE) of radiations from californium and radium. At high dose rates, the RBE for killing of mammalian cells usually varies with the degree of injury, being highest at low doses. At low dose rates, the RBE is more likely to be constant at all levels of injury but will vary with dose rate and distance from the californium. The RBE (Cf neutrons/Ra gamma rays) is ~ 5 for killing of intestinal crypt cells when the dose rate from radium is 160 rads/hour. At the lower dose rates used in radium therapy (30-70 rads/hour), the RBE (for Cf neutrons only) may be greater than 5. If the total dose (neutrons + gamma rays) from californium had been used in calculating the RBE at a source distance of 2 cm, the value would have been about 3.2. However, the better way of determining radium-equivalent doses is to apply RBE values separately to the neutron and gamma components of the californium emission. The increased hazard to incidentally irradiated normal tissues from substituting californium for radium in clinical radiotherapy is discussed. (auth)

18065 LONGEVITY AND MORTALITY DISTRIBUTIONS OF MICE WITH AND WITHOUT X-RAY EXPOSURE TO 45 GENERATIONS OF MALE PROGENITORS. Spalding, J. F.; Brooks, Mary R. (Los Alamos Scientific Lab., N. Mex.). Proc. Soc. Exp. Biol. Med.; 139: No. 1, 15-18(Jan 1972).

Longevity and mortality distributions were observed on two H-2 genotype substrains of mice within each of two lines. Two substrains ($H\text{-}2^f$ and $H\text{-}2^k$) were from 45 generations of x-irradiated male progenitors, and two were from nonirradiated progenitors with the same degree of inbreeding. Lifespan differed significantly for H-2 genotypes within the two lines but not for the same genotypes between lines. It was concluded that life shortening was not a genetic consequence of 45 generations of exposure to over 4500 times the background radiation level. The data also suggest a single-gene effect on longevity. (auth)

18066 CYSTEINE INTERFERENCE WITH CHLORAMBUCIL-INDUCED TERATOGENESIS IN THE RAT. Kernis, Marten M. (Univ. of Illinois, Chicago). Proc. Soc. Exp. Biol. Med.; 139: No. 1, 62-5(Jan 1972).

Pregnant rats were given a single injection of cysteine prior to exposure to chlorambucil on day 12 of gestation. This treatment caused a significant 6-fold increase in structurally normal surviving fetuses when compared to chlorambucil alone. The abnormal survivors demonstrated a less severe syndrome of anomalies that was not similar to the patterns of defects associated with chlorambucil treatment on other days of gestation. (auth)

18067 DISAPPEARANCE OF EXOGENOUS ERYTHROPOIETIN (ESF) FROM THE BLOOD OF GERMFREE MICE. Mirand, Edwin A.; Gordon, Albert S.; Zanjani, Esmail D.; Bennett, Theda E.; Murphy, Gerald P. (Roswell Park Memorial Inst., Buffalo. State University Coll., Buffalo. New York Univ., N. Y.). Proc. Soc. Exp. Biol. Med.; 139: No. 1, 161-4(Jan 1972).

A slower rate of disappearance of exogenous ESF from the plasma occurs in germfree mice as compared to normal mice. Higher plasma levels of ESF are maintained in x-irradiated than in non-irradiated mice. Possible mechanisms for these findings include a reduced ability of the liver to destroy ESF in the germfree animal and a decreased capacity of the blood-forming organs in the irradiated mouse to utilize the ESF. (auth)

18068 RADIATION CARCINOGENESIS AT LOW DOSES. Rossi, Harald H.; Kellerer, Albrecht M. (Columbia Univ., New York). Science; 175: No. 4018, 200-2(14 Jan 1972).

An analysis of experimental findings indicates that the induction of a mammary neoplasm in the Sprague-Dawley rat is dependent on the action of radiation on more than one cell. Although a linear relation between incidence and x-ray dose might be consistent with available data, such a relation would be fortuitous and linear extrapolation to lower doses is unjustified. (auth)

18069 EFFECT OF AGEING, CAFFEINE-TREATMENT, AND IONIZING-RADIATION ON NUCLEIC ACID SYNTHESIS IN THE MOUSE LIVER. Mitznegg, P.; Heim, F.; Hach, B.; Saebel, M. (Univ., Erlangen, Ger.). Life Sci., Part II; 10: No. 22, 1281-92 (22 Nov 1971).

In male white mice aged 2, 4, 6, 27, and 54 weeks, the incorporation rates of ^3H-thymidine and ^{14}C-orotic acid into liver nucleic acid were investigated. ^3H-thymidine incorporation proceeded at a high level in liver cells of young animals, showing strong activity in cell proliferation. DNA synthesis decreased in relation to aging. There were scarcely differences in incorporation of ^{14}C-orotate into RNA between young and older animals. Caffeine, at doses of 4 × 50 mg/kg, depressed DNA synthesis in young animals to a much higher degree than it did in older ones. When the proliferation of liver cells was enhanced in old animals

(54 weeks of age) by partial hepatectomy, caffeine-induced inhibition of DNA synthesis in partially hepatectomized 54-week-old mice corresponded to that which was observed in young animals aged 4 weeks. DNA synthesis was depressed by whole-body irradiation (500 rads) to a different degree in young and old animals. It was suspected that both, caffeine or whole-body irradiation, had a similar mode of action to decrease DNA reduplication, because DNA synthesis was depressed to the same amount by caffeine or x irradiation, respectively, and a combination of both agents showed no further inhibition. Independent of the age of the animals there was no influence of caffeine on RNA synthesis. So it was concluded that caffeine inhibited total DNA synthesis possibly by binding to DNA strand, whereas DNA-dependent synthesis of RNA molecules which are much smaller in molecular weight, was still possible. (auth)

Invertebrates

18070 (AED-CONF-71-100-47) APPLICATION OF RADIOISOTOPES AND IONIZING RADIATION FOR INSECT CONTROL. Kloft, W. (Bonn Univ. (West Germany)); Suess, A.; Haisch, A. (Bayerische Landesanstalt fuer Bodenkulture, Pflanzenbau und Pflanzenschutz, Munich (West Germany)). May 1971. 22p. (CONF-710901-534). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radioisotopes were used as tracers to study the feeding behavior and course of saliva injections of aphids (Ayzus ascalonicus donc and Aphic fabae) following the ingestion of ^{32}P or ^{86}Rb. Tritium-labeled water was used to measure transpiration rates in the cockroach, Periplaneta americana, and in the spider, Zygiella x-motata. Food transfer within populations of social insects was studied following the uptake of ^{32}P-sucrose solution by the Western honey bee (Apis mellifica) and the Eastern honey bee (Apis indica). Population dispersal studies were made on the European cherry fruit fly (Rhagoletis cerasi) released following the ingestion of trace amounts of stable dysprosium and subjected to neutron irradiation following capture. The neutron activation analysis method was found to mark the insects without influencing their behavior. Radiosterilization experiments with the European cherry fruit fly showed that doses of 6 to 8 kR γ radiation resulted in an egg mortality of 96 to 98% and also caused somatic damage. (C.H.)

18071 SELECTION FOR INCREASED ABDOMINAL BRISTLE NUMBER IN DROSOPHILA MELANOGASTER WITH CONCURRENT IRRADIATION. II. POPULATIONS DERIVED FROM AN OUTBRED CAGE POPULATION. Hollingdale, B.; Barker, J. S. F. (Univ. of Sydney). Theor. Appl. Genet.; 41: No. 6, 263-74(1971).

Replicate lines, each initially with one hundred pairs of parents selected at 50% intensity, were derived from the Canberra strain. In later generations population size was reduced and selection intensity increased. Three lines were selected without irradiation and five with 1000 R x-rays per generation for thirty generations. Selection was continued until generation 66. Lone-term responses were similar in unirradiated and irradiated lines, and there was evidence that genes with large effects influenced response patterns in both groups of lines. (auth)

18072 EFFECTS OF ANOXIC CONDITIONS ON RADIATION-INDUCED LIFE-SHORTENING IN SARCOPHAGA ADULTS. Sakka, Masatoshi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 9, 849-52(Dec 1970). (In Japanese).

Sarcophaga peregrina, a flesh fly, was given 40 kR of a single exposure of 50 kVp x-rays on the first day of adult life or 20 kR on the first and another 20 kR on the second day after emergence with an interval of one day in aerobic and anaerobic conditions and the residual life span was compared. Anaerobic conditions were produced by putting animals in a vacuum chamber or treating them with quenching gas for flow counters or with nitrogen gas. Animals were kept in anaerobic conditions for five minutes before, through the end of irradiation. Anaerobic treatment has no more early and late effects than a temporary anaesthetic state in flies. It was previously reported that anaerobic conditions protected Sarcophaga pupae from acute as well as late radiation effects but in adults neither single anaerobic irradiation nor split dose technique associated with anoxia produced any protective effects on radiation-induced life shortening. Complete absence of modification of radiation effects by anoxia in adult flies may be explained by irreversible accumulation of injuries in non-dividing cells of adult insects. (auth)

18073 UV IRRADIATION OF POLAR CELLS OF DROSOPHILA MELANOGASTER EGGS. II. ESTIMATION OF THE NUMBER OF POLAR CELLS AT THE ORIGIN OF THE GERMINAL LINE. Prudhommeau, Claude; Lauge, Ginette (Faculte des Sciences, Orsay, France). Mutat. Res.; 14: No. 1, 43-52(Jan 1972). (In French).

Polar cap cells of Drosophila eggs were irradiated with uv doses ranging from 750 to 1200 erg/mm^2. One of the important observations relates to the incidence of sterility among the surviving males and its dependence on the dose of uv irradiation. Histological examination of the sterile males showed that such males have agametic testes. Data on the dose–frequency relationship of induced sterility in surviving males, the frequency of fertile males with only one functional testis, and the relative size of mutant or crossover clusters induced by irradiation are presented and discussed. Also presented are the results of the histological study of polar cells incorporated in gonads after irradiation. The results of the present experiments show that the uv killing of the polar cells follows a one-hit kinetics and that the medium number of polar cells that constitute the progenitors of all gametes after irradiation is very small; the latter is on the order of 1 at a dose of 1000 erg/mm^2. (auth)

18074 UV IRRADIATION OF POLAR CELLS OF DROSOPHILA MELANOGASTER EGGS. III. STUDY OF MITOTIC RECOMBINATION INDUCED IN THE MALE. Prudhommeau, Claude (Faculte des Sciences, Orsay, France). Mutat. Res.; 14: No. 1, 53-64(Jan 1972). (In French).

The uv induction of genetic recombination in Drosophila males was studied by irradiating polar cap cells in eggs with doses ranging from 750 to 1200 erg/mm^2. About 1000 males (heterozygous for genes on the second and third chromosomes) derived from the irradiated eggs were screened and 33 of these males showed certain disturbances in the segregation of the marker genes employed in the study. The data permit the following conclusions to be drawn: (1) Clusters of induced mitotic crossovers appear very early; they are sometimes large in size and in fact all the descendants of a male may be exclusively of the crossover class. In most instances, however, the cluster size is greatly reduced. (2) The clusters include either two reciprocal crossover classes or only one or two nonreciprocal classes; in particular, when double crossovers are observed, there is no reciprocity. Several hypotheses to explain the origin of crossovers and the absence of reciprocity are presented and discussed; it appears that the latter is not due to the elimination of one of the crossovers. It is suggested that uv irradiation induces chromosomal lesions which, at the time of DNA replication, lead to mitotic recombination. The latter could originate through triplication of a small chromosomal segment. (auth)

Radionuclide Effects (Internal Source)

18075 COMMENT ON ESTIMATION METHODS OF ABSORBED DOSE DUE TO TRITIUM. Shiragai, Akihiro (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 12: No. 2, 73-86(Jun 1971).

It was attempted to estimate the absorbed doses in cells after incorporation of tritium with the constant absorption model. The point source dose distribution, the dose distributions due to tritium locally incorporated, the fraction of self-absorption in spherical source, and the fraction absorbed in sphere of energy emitted from the source around the sphere could be analytically calculated with the constant absorption model, where the beta-spectrum was divided into eighteen one-keV intervals and the beta-particles were supposed to have the middle energy in each energy group. Furthermore the results were compared with the other ones and the questionable points contained in these estimation methods investigated. Then it was pointed out that the stopping power and the transmission probability of low-energy electrons would be required to be established theoretically and experimentally. (auth)

Man

Refer also to abstracts 17431, 17808, and 18003.

18076 COMMENT: RADIONUCLIDE CARCINOGENESIS AND SINUS CARCINOMA. Rubin, Philip. J. Amer. Med. Ass.; 219: No. 3, 354-7(17 Jan 1972).

Data are reviewed from a number of studies on the neoplastic effects of bone seeking radionuclides deposited in man. These studies show that α-emitters are more effective carcinogens than β-emitters, and that α-emitters deposited on the surface of bone are more toxic than dose in its volume, because more energy is absorbed by cells than by minerals. Once a radionuclide has been

deposited in tissue it undergoes physical decay and the radiation dose delivered decreases with time. The induction period for neoplasms consists of a sequence of pathologic transformations. Problems involved in establishing the radiation dose at the instant of malignant transformation of a cell into a tumor cell and the dosimetry of radionuclides deposited in bones are discussed. Data on 496 persons having skeletal body burdens of radium (^{226}Ra and its daughters) showed that no tumors were observed at doses below 1,200 rads and the tumor incidence in persons with body burdens above 1,200 rads was 40%. Data on another group of 293 persons with radium body burdens (^{226}Ra and its daughters) showed that no tumors were observed in persons whose body burden was below 1.2 μ Ci. Of the 46 malignant tumors found in this group, 23 were bone tumors, 16 were cancer of the paranasal air sinus or mastoids, and seven were leukemias or aplastic anemias. The lowest estimated radium burden for patients with bone sarcoma was 6.72 μCi, whereas for those with neoplasms of the sinus it was only 1.23 μCi. Measurements of the radon concentration in the sinus and maxillary air spaces showed that radon and its daughter products produced a cumulative dose to the region of basal cells in the sinus epithelium that exceeded 82,000 rads. (C.H.)

Animals

18077 ^{90}Sr INDUCED TRANSLOCATIONS IN MICE. Reddi, O. S. (Osmania Univ., Hyderabad, India). Indian J. Med. Res.; 59: No. 4, 574-7(4 Apr 1971).

A total of 42 F_1 males obtained from 20 males treated with ^{90}Sr were tested for induced reciprocal translocations by genetic and cytological methods. Of these, only three males (7.1%) were found to carry the particular genetic aberrancy tested. (auth)

18078 HISTOPHYSIOLOGICAL CHANGES IN THE THYROID GLAND OF THE INDIAN PALM SQUIRREL FUNAMBULUS PENNANTI (WROUHTON) IN RESPONSE TO VARIED DOSES OF RADIOIODINE. Vijayan, E.; Sathyanesan, A. G. (Banaras Hindu Univ., India). Endokrinologie; 58: No. 1, 37-54(1971).

Histophysiological changes occurring in the thyroid of Indian palm squirrel F. pennanti in response to varied doses of ^{131}I ranging from 50 μCi to 1500 μCi were studied. Degenerative changes obtained in the thyroid are dose dependent. At lower dose levels those follicles which accumulate more of ^{131}I exhibited maximum radiation injury which is characterised by break down of follicles, edema, lymphocytic infiltration and inflammatory changes of blood vessels. The regenerating glands exhibit extensive fibrosis, hypertrophy of the follicles occasionally resulting in Askanazy changes. Nuclear pleomorphism and occasional encapsulated cysts were also noticed. 500 μCi and 1 mCi of ^{131}I cause radiothyroidectomy in 3 to 5 months and 2 to 3 months respectively. Histopathological observations were supported by iodine uptake and radioautographic studies. At all dose levels, the thyrotrophs of the anterior pituitary exhibited extensive hypertrophy, characterised by cytoplasmic vacuolisation and formation of cystic masses by fusion of adjacent ones. Hypertrophy of the thyrotroph correlates well with that of the follicular epithelium of the thyroid and hence the latter is under TSH stimulation. Doses of 500 μCi and above cause degenerative changes in certain areas of the parathyroid. (auth)

Plants

Refer also to abstract 17970.

Nuclide Kinetics and Toxicology

Man

18079 ^{67}Ga-ACCUMULATION IN MALIGNANT TUMORS AND IN THE PRELACTATING OR LACTATING BREAST. Fogh, Jan (Rigshospitalet, Copenhagen). Proc. Soc. Exp. Biol. Med.; 138: No. 3, 1086-90(Dec 1971).

It was confirmed that carrier free ^{67}Ga has a uniquely high affinity for malignant tumors. The mechanism by which ^{67}Ga is taken up by the tumor cells is unknown. It was observed that physiological changes in the mammary glands during pregnancy enable this organ to accumulate ^{67}Ga. This observation may be of importance for further studies on the biological behavior of gallium and for studies on malignant tissues. (auth)

18080 AGE-DEPENDENT INHALATION DOSE FACTOR OF ^{131}I. Bayer, A. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 1, 35-7(Jan 1972). (In German).

Comparisons were made of the air consumption rates, and the mass of the thyroid glands in individuals ranging from the newly-born to adults. An inhalation dose factor was calculated for ^{131}I and shown to be a function of age, having a maximum value at the age of 0.5 yr. (K.S.W.)

18081 BREAD IODINE CONTENT AND THYROID RADIOIODINE UPTAKE: A TALE OF TWO CITIES. Sachs, Bernard A. (Albert Einstein Coll. of Medicine, Bronx, N. Y.); Siegel, Edward; Horwitt, Benjamin N.; Siegel, Elsie. Brit. Med. J.; 1: No. 5792, 79-81(8 Jan 1972).

The iodine content of bread consumed in the Bronx, New York, was found to be significantly lower than that of bread consumed in Columbia, Missouri. This difference in dietary intake of iodine could account for the lowered range of normal values for 24-hr ^{131}I uptake tests in Columbia, and the persistence of the same normal range for this test over the past 28 yrs in the Bronx. It is pointed out that a population with high iodine intake would require higher doses of radioactive iodine in the diagnosis and treatment of thyroid disease. The relationship of high iodine intake to the risk of developing thyrotoxicosis is discussed. (auth)

18082 THYROIDAL ^{131}I TURNOVER IN HYPOTHYROIDISM: ABERRANT RESULT IN PRIMARY HYPOTHYROIDISM. Wierum, Carl (Englewood Hospital, N. J.). J. Clin. Endocrinol. Metab.; 33: No. 5, 857-8(Nov 1971).

A case of primary hypothyroidism is presented (documented by elevated TSH titer), in which the ^{131}I taken up by the thyroid gland persisted for several days, close to the 24 hour uptake level. This contrasts with the expected behavior of thyroidal ^{131}I in this condition, and constitutes an exception to previously reported reliable separation of primary from secondary hypothyroidism based on rate of disappearance of ^{131}I from the thyroid. (auth)

18083 ^{55}Fe IN HUMAN BLOOD IN NORWAY, 1967–1969. Lekven, J. (Norwegian Defense Research Establishment, Kjeller). Nature (London); 235: No. 5336, 284-6(4 Feb 1972).

Blood samples from a number of locations in Norway were analysed; the method of analysis is described. There was no obvious correlation between ^{55}Fe in blood and precipitation during the probable period of fallout accumulation (1961 to 1966). There appear to be two main ecological routes for accumulation of ^{55}Fe in man: a sea-plankton-fish-man chain, and a lichen-caribou-Eskimo chain. The samples included some from coastal cities with good access to ocean fish and some from farming and agricultural districts, also some from high precipitation districts. Results are shown in tabular form. Typical reindeer eating Lapps showed ^{55}Fe concentrations of around 20 nCi/l, whereas more urbanised Lapps showed ~10 nCi/l. Reduction of 50% is estimated as taking 2 to 2–5 yr., and the biological half-life for ^{55}Fe in human blood appears to be relatively long. Some data are given for body burdens. Dose to the erythrocytes from hemoglobin incorporation is slightly higher than to the adjacent plasma, other blood cells and vessel walls. The effects of the ionising radiation on the spleen and blood forming red bone marrow are compared; also the effects on the proteins ferritin and haemosiderin. Males showed higher ^{55}Fe concentrations than females and reasons for this are discussed, mainly in terms of the difference in Fe metabolism. There was no statistical difference with regard to age. (UK)

18084 ^{90}Sr IN THE BONE OF DIFFERENT SOUTH AFRICAN POPULATION GROUPS. van As, D.; Fourie, H. O. (Atomic Energy Board, Pelindaba, S. Afr.). S. Afr. Med. J.; 45: 694-6 (26 Jun 1971).

The ^{90}Sr content of a large number of bone samples from South Africans of different race and age groups has been measured. Significant differences were found between population groups especially in the age group 5 to 20 years. The ^{90}Sr content of foodstuffs which are the main contributors to the total ^{90}Sr in the diet, e.g., milk, bread and maize was also measured during the period 1966 to 1969. The two main population groups, Whites and Bantu, have vastly different dietary habits and consequently quite different calcium intakes and sources of ^{90}Sr in their diets. Calcium and ^{90}Sr intakes from different foodstuffs were calculated from dietary surveys. An inverse proportionality was found between the dietary calcium intake and the ^{90}Sr content of bone. (auth)

18085 PROLONGED MEASUREMENT OF ^{133}Xe DISAPPEARANCE FROM SUBCUTANEOUS TISSUE OF THE FOOT. Ahlstroem, H.; Westling, H. (Dept. of Clinical Physiology, Lund, Sweden). Scand. J. Clin. Lab. Invest.; 28: No. 4, 401-7 (Dec 1971).

^{133}Xenon dissolved in 0.9% NaCl was injected subcutaneously into the dorsum of the foot. In normals, ^{133}Xe clearance increased when histamine was added, after indirect heating, and after posterior tibial nerve block. The changes after nerve block were as great as the changes in cutaneous blood flow, estimated from the initial clearance rate of ^{133}Xe introduced epicutaneously by diffusion. In acute severe ischaemia, ^{133}Xe clearance was very slow, but in chronic gangrene abnormally high values were noted. Angiotensin infusion increased ^{133}Xe clearance in parallel with disappearance of ischaemic pain. Intermittent walking was not associated with a reduced cumulative clearance rate as measured over some hours. (auth)

18086 ^{90}Sr IN HUMAN VERTEBRAE IN CZECHOSLOVAKIA, 1964–1969. Brezik, Z. (Inst. of Hygiene and Epidemiology, Prague). Radiol. Health Data Rep.; 12: No. 11, 541-6(Nov 1971).

The Institute of Radiation Hygiene has been conducting a continuous determination of strontium-90 in human vertebrae since the beginning of 1964. Specimens were collected at autopsies of inhabitants of Prague and Middle Bohemia, aged 0 to 60 years. In the period, 1964 to 1969, about 1,450 specimens were analyzed and the results divided into 12 age groups. The peak strontium-90 level occurred in 1964 in child group 6 to 11 months. In the following years, the decreasing trend of strontium-90 values is evident especially in child groups. A frequency histogram of values obtained displays a slightly positive skewness in all years of the study. When plotted, the data indicate a log normal distribution. A comparison is made with data during a corresponding period in the United States and some European countries. (auth)

18087 HUMAN EXPOSURE TO NATURAL URANIUM. A CASE HISTORY AND ANALYTICAL RESULTS FROM SOME POSTMORTEM TISSUES. Donoghue, J. K.; Dyson, E. D.; Hislop, J. S.; Leach, A. M.; Spoor, N. L. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Brit. J. Ind. Med.; 29: No. 1, 81-9(1972).

After the collapse and sudden death of an employee who had worked for 10 yrs in a natural uranium workshop, in which the airborne uranium was largely U_3O_8 with an Activity Median Aerodynamic Diameter in the range 3.5 to 6.0 μm and average concentration of 300 $\mu g/m^3$, his internal organs were analyzed for uranium. The tissues examined included lungs (1041 g), pulmonary lymph nodes (12 g), sternum (114 g), and kidneys (217 g). Uranium was estimated by neutron activation analysis, using irradiated tissue ash, and counting the delayed neutrons from ^{235}U. The concentrations of uranium (μg U/g wet tissue) in the lungs, lymph nodes, sternum, and kidneys were 1.2, 1.8, 0.09, and 0.14 respectively. The weights deposited in the lungs and lymph nodes are less than 1% of the amounts calculated from the environmental data using the parameters currently applied in radiological protection. The figures are compatible with those reported by Quigley, Heatherton, and Ziegler (1958) and by Meichen (1962). The relation between these results, the environmental exposure data, and biological monitoring data is discussed in the context of current views on the metabolism of inhaled insoluble uranium. (auth)

Animals

Refer also to abstract 17742.

18088 FACTORS INFLUENCING ^{45}Ca METABOLISM IN BRAIN AND OTHER ORGANS IN VIVO. Cooke, William J.; Robinson, Joseph D. (State Univ. of New York, Syracuse). Proc. Soc. Exp. Biol. Med.; 138: No. 3, 906-12(Dec 1971).

The distribution of ^{45}Ca among various tissues of the rat was followed for 8 hr after intravenous administration of the isotope. Three major patterns of ^{45}Ca turnover were demonstrable, represented by: brain; bone; and certain soft tissues: kidney, adrenal, and muscle. These differences may be explained in terms of different exchange (e.g., for bone) and physiological barriers (e.g., for brain). Studies on the subcellular distribution of ^{45}Ca in brain, performed 2 hr after intravenous administration of $^{45}CaCl_2$, showed that mitochondria accumulated 25% of the total ^{45}Ca; moreover, the concentration of the ^{45}Ca accumulated by the mitochondria was decreased by prior administration of phenobarbital and of reserpine, but increased by pentylenetetrazol. (auth)

18089 FINE STRUCTURE OF RAT CORNEAL VESSELS IN ADVANCED STAGES OF WOUND HEALING. I. PERMEABILITY TO INTRAVENOUSLY INJECTED THORIUM DIOXIDE. Szalay, Jeanne; Pappas, George D. (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Microvasc. Res.; 2: 319-29(1970).

The permeability of corneal blood vessels in advanced stages of wound healing in the Sprague–Dawley rat after intravenous injection of Thorotrast was studied using the electron microscope. The mature corneal vessels show remarkably little leakage of thorium dioxide, in contrast to the marked leakage observed in structurally similar vessels of the limbus of the eye and the skin of the paw. These findings emphasize the differences in susceptibility of various tissues to inflammation. (auth)

18090 INTESTINAL EXCRETION OF ^{85}Sr AND ^{47}Ca DURING FEEDING AND FASTING IN RATS. Warren, Janet M.; Spencer, Herta (Veterans Administration Hospital, Hines, Ill.). Radiat. Res.; 48: No. 3, 578-88(Dec 1971).

The excretion of ^{47}Ca and ^{85}Sr from the vascular space into the intestine was determined in three weight groups (100, 250 and 400 g) of Sprague–Dawley rats during feeding and fasting. Both isotopes were injected intravenously and the animals were sacrificed 24 hours following administration of the dose. During feeding, ^{85}Sr was excreted into the intestine to a slightly greater extent than ^{47}Ca and the intestinal excretion of both isotopes increased to some extent with age. During fasting, considerably less of both isotopes was excreted via the intestine but the increase in intestinal excretion with age was more marked. The decrease in the intestinal excretion during fasting was greater for ^{47}Ca than for ^{85}Sr, so that the ^{85}Sr/^{47}Ca ratio increased from 1.3 during feeding to 2.2 during fasting. ^{85}Sr was excreted in urine to about the same extent as in the feces during feeding and fasting while the urinary excretion of ^{47}Ca was considerably lower than the fecal ^{47}Ca excretion during both study conditions. The uptake of ^{85}Sr in bone was lower than that of ^{47}Ca during both feeding and fasting but the bone uptake of both isotopes was significantly greater during fasting than feeding. This increase in bone uptake corresponded to the decrease in urinary and fecal excretions of the two radioisotopes during fasting. (auth)

18091 EFFECT OF MALONATE, SUCCINATE, AND GLUCOSE, IN VIVO, ON THE UPTAKE OF ^{137}Cs BY PIGEON (COLUMBA LIVIA) MUSCLES. Narayanan, N.; Eapen, Jacob (Bhabha Atomic Research Centre, Bombay). J. Radiat. Res.; 12: No. 2, 56-60(Jun 1971).

The in vivo effects of malonate, succinate, and glucose on ^{137}Cs uptake by muscles of pigeon were studied. At 15 μg malonate/g body the radionuclide uptake in red muscle, white muscle, cardiac muscle, and smooth muscle was found to be reduced by 27, 14, 23, and 27% respectively in comparison to the controls. The inhibition of radiocesium uptake was even more pronounced at 25 μg malonate/g body with as much as 68% reduction of uptake in red muscle. Succinate and glucose enhanced the uptake of ^{137}Cs in varying degrees in all the muscles. Moreover, both succinate and glucose could overcome the inhibitory effect of malonate in all the tissues except smooth muscle. (auth)

18092 GROSS AND SUBCELLULAR DISTRIBUTION OF ^{137}Cs IN PIGEON (COLUMBA LIVIA) TISSUES WITH SPECIAL REFERENCE TO MUSCLES. Eapen, Jacob; Narayanan, N. (Bhabha Atomic Research Centre, Bombay). J. Radiat. Res.; 12: No. 2, 51-5(Jun 1971).

A study on the gross distribution of ^{137}Cs in pigeon tissues showed that initially cardiac muscle acquired the maximum amount of the radionuclide followed by pancreas, liver, gizzard, red muscle, and white muscle in that order. Over a period of time white muscle showed more radioactivity than the other tissues because it accumulated ^{137}Cs steadily and lost the radionuclide more slowly. Among the subcellular fractions, the supernatant had 65 to 80%, nuclear fraction 12 to 21%, mitochondria 1.1 to 10%, and microsomes 0.45 to 3.4% radioactivity indicating that the major portion of ^{137}Cs in cells occurs in soluble form. (auth)

18093 IDENTIFICATION OF [^{75}Se]SELENOMETHIONINE IN EWE MILK PROTEIN FOLLOWING THE INTRARUMINAL ADMINISTRATION OF $Na^{75}SeO_3$ AS A SINGLE ORAL DOSE. Godwin, K. O.; Handreck, K. A.; Fuss, Christine N. (CSIRO, Adelaide). Aust. J. Biol. Sci.; 24: No. 6, 1251-61(Dec 1971).

Inorganic selenium, as $Na_2{}^{75}SeO_3$, was given intraruminally to lactating ewes, and for 48 hr afterwards samples of blood and milk were taken regularly. The animals were then slaughtered and tissues taken for further analysis. Evidence is presented, based on isolation techniques using Sephadex chromatography and gas–liquid chromatography, that ^{75}Se is incorporated into milk proteins as selenomethionine. It is estimated that at least 3% of the selenium that enters the milk, from this inorganic source, is present as bound selenomethionine. This is a minimal value, since it was shown that selenomethionine is easily degraded during a number of the isolation procedures. The steps followed

in arriving at the conclusion were: a large proportion of the ^{75}Se activity in the milk was non-dialysable; activity emerges with the milk protein on Sephadex and can be recovered as "soluble casein" by precipitation with ammonium sulphate; Pronase digestion of the labeled protein produces fragments that behave like methionine and cysteine in column chromatography; and gas–liquid chromatography, including collection of the effluent in fractions, has enabled positive identification of a (^{75}Se)selenomethionine peak. Other selenoamino acid-like fractions are present but have not yet been identified. (auth)

18094 BILIARY EXCRETION OF ^{203}Hg, ^{64}Cu, ^{52}Mn, AND ^{210}Pb IN THE RAT. Cikrt, M. (Inst. of Industrial Hygiene and Occupational Diseases, Prague). Brit. J. Ind. Med.; 29: No. 1, 74-80(1972).

The biliary excretion of ^{52}Mn, ^{64}Cu, ^{203}Hg, and ^{210}Pb after intravenous administration of $^{52}MnCl_2$, $^{64}CuCl_2$, $^{203}HgCl_2$, and $^{210}Pb(NO_3)_2$ in non-toxic doses was studied in rats. Cumulative biliary excretion reached by 24 hours after administration in the case of ^{64}Cu 31.06%, of ^{52}Mn 26.7%, of ^{203}Hg 3.8%, and of ^{210}Pb 6.7% of the administered dose. The excretion curve for ^{203}Hg differed significantly from those of the other three metals. The maximum rate of excretion was reached at different periods after administration for each metal. The excretion of the metals via the wall of the gastrointestinal tract during 24 hours after administration was also studied. The excretion into faeces occurred mainly via the bile; to a lesser extent there was excretion through the wall, probably chiefly of the upper segments of the digestive tract. (auth) (UK)

18095 STUDY OF ^{141}Ce RESORPTION AND ACCUMULATION IN SOME ORGANS AND TISSUES OF RUMINANTS AND ITS EXCRETION WITH MILK. Stanchev, Kh.; Lazarov, J.; Danev, Kh. Zhivotnovud. Nauki; 8: No. 1, 15-19(1971). (In Bulgarian).

An experiment was conducted with four lactating goats, injected with 10 μCi/kg ^{141}Ce in the form of cerium(III) chloride. Results show that ^{141}Ce resorption is extremely small in the digestive tract of ruminants during all hours of observation—activity ranges from 0.296 pCi/ml for the first hour, reaching 0.364 pCi/ml at the 24th hour. Cerium-141 accumulation in the examined organs is negligible, liver activity being 0.150 pCi/g, kidney—0.133 pCi/g, m.gastrocnemius—0.152 pCi/g and rib bone—0.114 pCi/g. No major differences were found in ^{141}Ce accumulation in the examined organs and tissues in goats sacrificed on the 4th and the 24th hour. Cerium-141 was incorporated in the milk in negligible amounts, its activity ranging from 0.182 pCi/ml to 0.243 pCi/ml, at the 30th minute and at the 24th hour, of isotope introduction. (auth) (INIS)

18096 INFLUENCE OF MAGNESIUM CHLORATE ON THE DISTRIBUTION OF ^{131}I IN TISSUES AND ORGANS OF WHITE RATS. Nazarova, O. B. (Turkmen State Medical Inst., USSR). Zdravoorhr. Turkm.; 1: 18-20(1970). (In Russian).

The transport of ^{131}I throughout the organs of experimental animals and distribution in tissue in the presence of magnesium chlorate were investigated. The $Mg(ClO_3)_2$ was fed to rabbits and white rats by mixing with their normal diet for one month. The ^{131}I was administered intraperitoneally and after two hr the animals were sacrificed in order to measure the accumulation of the isotope in organs. The hyaluronidase activity of the blood serum was measured in the rabbits. The distribution of ^{131}I in various organs did not differ significantly from that in control animals, however the rate of uptake in the $Mg(ClO_3)_2$-treated animals was much greater. (K.S.W.)

18097 COMPARATIVE HISTOAUTORADIOLOGICAL INVESTIGATION OF THE DISTRIBUTION OF ^{210}Po IN THE LIVER IN ITS INTRAVENOUS AND INTRATRACHEAL ADMINISTRATION. Solov'ev, A. I. Arkh. Patol.; 33: No. 11, 23-8(1971). (In Russian).

By means of calculating alpha-particles tracks in historadioautographs, the author studied the dynamics of changes of the liver activity in intravenous and intratracheal administration of ^{210}Po into the organism of rabbits. A principal difference in the distribution of the emitter and in the character of structural changes, especially at the beginning of the affection, was established. (auth)

Plants

18098 SOME DATA ON ^{65}Zn AND ^{55}Fe UPTAKE IN THE SEEDS OF SOME CARYOPHYLLACEAE. Micle, F.; Cachita-Cosma, D.; Popovici, Gh.; Ionica, A. Stud. Univ. Babes-Bolyai, Ser. Biol.; 16: No. 1, 95-100(1971). (In Rumanian).

Investigations concerning radioelement absorption by old and new harvested seeds of 13 Caryophyllaceae are reported. The uptake and accumulation of ^{55}Fe and ^{65}Zn as water-soluble $^{55}FeCl_3$ and $^{65}ZnCl_2$ were studied, their activity being 0.25 μCi/ml, during the two day inhibition. It was found that old seeds accumulated either cation more steadily than the fresh ones. (Rom. Sci. Abstr.) (auth)

18099 EFFECTS OF SOIL FACTORS ON THE UPTAKE OF RADIOSTRONTIUM BY PLANTS. PART III. Paasikallio, A.; Haekkinen, U.; Lakanen, E. (Agricultural Research Centre, Tikkurila, Finland). Ann. Agr. Fenn., Ser. Agrogeol., -Chim. -Phys.; 10: No. 54, 125-30(1971).

Pot experiments with oats were carried out with some Finnish peat types differing from each other in their degree of decomposition, with bark humus, which is a decomposition product of conifer bark, and with fractionated organic materials. These last included humin and humic acids mixed with fine sand in varying proportions. The proportional uptake of ^{89}Sr in relation to Ca by plants growing in peat soils was found to decrease with increasing C/N ratio, and with increasing humic acid content and CEC (meq/1) of the growth medium. Increasing amounts of various fractions of organic matter (humin, and humic acids) mixed with a fine sand decreased the uptake of radiostrontium and calcium by plants. However, the $^{89}Sr/Ca$ ratio of the plants increased when the organic matter content of the soil was low. (Finland)

New Tracer Techniques

Refer also to abstracts 17557 and 18070.

18100 DIAGNOSIS OF LUNG TUMORS. Muehe, E. (Univ., Erlangen, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed.; 115: No. 4, 496-501(Oct 1971). (In German).

A positive scan with ^{67}Ga is the simplest method of demonstrating malignant tumors in the chest. Diagnosis depends on the much higher retention of the radionuclides in the malignant tumor, as compared with the lung parenchyma. In a large series of cases examined by the author, gallium scans were better at differentiating malignant from benign tumors than any other method of examination, including bronchoscopy, mediastinoscopy, and sputum examination. There are no contra-indications to this method. It can be performed on out-patients and causes little discomfort. Further examinations to detect recurrences or metastases are easily performed. It is difficult to demonstrate tumors that were irradiated or are undergoing regression, either spontaneously or as a result of cytotoxic drugs. Further, it is rarely possible, for physical reasons, to demonstrate tumors with a diameter of less than 3 cm. (auth)

18101 INDIRECT RADIOISOTOPE LYMPHOGRAPHY OF PARASTERNAL LYMPH NODES IN CANCER OF THE MAMMARY GLAND. Korsunskii, V. N.; Edemskii, Yu. I.; Danichev, D. R.; Ostrovtsev, L. D. (Research Inst. of Oncology, Moscow). Vop. Onkol.; 17: No. 9, 11-16(1971). (In Russian).

Using a method of indirect radioisotope lymphography of parasternal lymph nodes, 26 patients with cancer of the mammary gland were investigated. 300 mCi of ^{198}Au colloid were injected subcutaneously subxiphoidally. Scanning was performed 24 hr following injection of this preparation. A possibility to determine metastatic involvement of parasternal lymph nodes is emphasized. However, the reliability of results of indirect radioisotope lymphography is not adequate since in some cases the distribution of colloid gold is variable and could not correspond to the true picture. (auth)

18102 LOCALIZATION OF RADIOACTIVITY IN IMMATURE RAT OVARIES FOLLOWING PHYSIOLOGICAL DOSES OF ^{125}I-LABELED BOVINE LH. Barofsky, Anna-Lisa; Lipner, Harry J.; Armstrong, David T. (Harvard Medical School, Boston. Florida State Univ., Tallahassee). Proc. Soc. Exp. Biol. Med.; 138: No. 3, 1062-7(Dec 1971).

Bovine LH was labeled with ^{125}I by chloramine T oxidation and gel filtration. Immunological characterization of iodinated LH, using either gel filtration on Sephadex G-200 or double antibody precipitation to separate free and antibody-bound ^{125}I-LH, indicated that 71 and 64%, respectively, of total radioactivity was reactable with antibody to bovine LH. A dose of ^{125}I-LH within the physiological range (51 ng/100 g of body wt) was administered intravenously to immature female rats. Serum samples, ovaries, adrenals, thyroids, and portions of liver were taken for radioassay at times ranging from 5 min to 12 hr following injection.

Disappearance of radioactivity from blood approximated a hyperbolic function with a half-life of 19.6 min. Radioactivity in liver at its 15-min maximum represented 43% of the total injected dose per whole organ. Radioactivity in ovary and adrenal appeared at similar low levels (0.05 to 0.07% of injected dose per pair of glands). Disappearance curves from the two organs, however, were significantly different, with radioactivity in ovary, but not in adrenal, being retained up to 30 min following injection. (auth)

18103 ANALYSIS OF CORTICOSTEROIDS IN BIOLOGICAL SAMPLES. II. RADIOISOTOPIC METHODS. Noujaim, A. A.; Jeffery, D. A. (Univ. of Alberta, Edmonton). Can. J. Pharm. Sci.; 6: No. 1, 1-8(1971).

A comparison of the methods available for the determination of corticosteroids shows that the double isotope derivative dilution method offers great advantages in sensitivity and precision. Competitive protein binding radioassays and fluorometric methods have sensitivities in the nanogram range, while spectrophotometric methods have sensitivities in the microgram range. The advantage of sensitivity and precision of the double isotope methods is offset by the very time-consuming nature of this type of analysis; only a few samples can be processed each week. From the point of view of speed, simplicity and practicability for routine use the spectrophotometric, fluorometric, and CPB methods are much more satisfactory. The sample size used can be important where repeated determinations are necessary. For this reason the CPB method offers the greater advantage since less than 1 ml of plasma can be used. Fluorometric methods may be used for these small volumes of plasma if special microcuvettes are employed. With regard to specificity, the double isotope analysis is probably the best, since many purification steps are possible; however, since the activity used is fairly high, radioactive contamination is possible. This would give erroneously high results. Spectrophotometric and fluorometric methods are both susceptible to non-steroid interference which detracts from the specificity of these methods. The CPB method has been shown to be free of non-steroid interference and has been claimed to exhibit specificity for particular steroids. The CPB method probably represents the best available compromise of sensitivity, precision, speed, simplicity and specificity. (Canada)

18104 RADIOIMMUNOASSAY OF THYROXINE. Chopra, I. J.; Solomon, D. H.; Ho, R. S. (Harbor General Hospital, Torrance, Calif. Univ. of California, Los Angeles). J. Clin. Endocrinol. Metab.; 33: No. 5, 865-8(Nov 1971).

A simple, sensitive, specific and precise radioimmunoassay (RIA) for measurement of serum thyroxine (T_4) is described. The RIA employs rabbit anti-thyroglobulin antiserum as the T_4-binding protein. The precision, reproducibility and practicality of the RIA are comparable to those of competitive protein binding assay (CPBA) using serum TBG as the T_4-binding protein. (auth)

18105 RADIOIMMUNOASSAY OF PLASMA ESTRIOL. Tulchinsky, Dan; Abraham, Guy E. (Los Angeles County Harbor General Hospital, Torrance, Calif.). J. Clin. Endocrinol. Metab.; 33: No. 5, 775-82(Nov 1971).

A radioimmunoassay for the measurement of plasma unconjugated estriol (E_3) is described that was tritium-labeled steroids. The hemiscuccinates of E_3 were coupled to human serum albumin using carbodiimide, and the conjugates were used to immunize four ewes. One of the antisera obtained after three months of immunization was used in the assay procedure. Celite microcolumns were used to separate E_3 from estrone and estradiol-17β. Separation of bound from free radioactive hormone was achieved by a dextran-coated charcoal suspension. The assay sensitivity was 25 pg, with a within-assay variance of 7% and a between-assay variance of 9%. Plasma E_3 from 167 unselected pregnant patients showed a constant rise of the mean plasma E_3 from 1.7 ± 0.2 ng/ml (SE) at 16 to 18 weeks to 11.1 ± 0.7 ng-ml at term. After the 32nd week of pregnancy no level below 4 ng/ml was found. In pregnancies with intrauterine fetal demise, the plasma concentration of unconjugated E_3 was below 4 ng/ml. The postpartum clearance of endogenous E_3 was measured and found to fit a two-compartment model with mean $T_{\frac{1}{2}}$ of 22 minutes and 9 hours. A patient with molar pregnancy and three patients studied more than 5 days after fetal demise, still had E_3 plasma concentrations of 0.3–0.5 ng/ml, suggesting some extra-fetal production of plasma E_3. (auth)

18106 RADIOIMMUNOASSAY OF VASOPRESSIN: APPLICATION TO UNEXTRACTED HUMAN URINE. Oyama, Stanley N.; Kagan, Avir; Glick, Seymour M. (Coney Island Hospital, Brooklyn). J. Clin. Endocrinol. Metab.; 33: No. 5, 739-44(Nov 1971).

A sensitive, specific radioimmunoassay has been developed for arginine vasopressin (AVP). It is capable of detecting <0.1 μU/ml. Lysine vasopressin displaces AVP ^{131}I from antibody to AVP more strongly than did AVP itself, but oxytocin and other vasopressin analogues cross reacted much less strongly. AVP was detected in unextracted human urine, with excretory rates of 1.2 to 6.5 mU/hr observed during 24 hour dehydration, and rates of 0 to 0.35 mU/hr during water loading. Urinary immunoreactivity was similar in size to AVP as determined by dialysis, ultrafiltration, and passage through a Sephadex G-15 column. (auth)

18107 DETECTION OF CARDIAC RIGHT-TO-LEFT SHUNTS BY EXTERNAL COUNTING OF ^{133}Xe. Uhrenholdt, A. (Rigshospitalet, Copenhagen). Scand. J. Clin. Lab. Invest., 28: No. 4, 395-400(Dec 1971).

^{133}Xenon appearance times were recorded externally over the abdominal part of the aorta and the precordium in 43 patients, 15 of whom had a cardiac right-to-left shunt. Significantly shorter appearance times were found in the shunt group both after tracer injection in a peripheral arm vein and in the superior caval vein. False negative and false positive results due to individual differences in the distribution volume and flow rate of the indicator are discussed. The method provides a qualitative measure of cardiac right-to-left shunts, and is suggested as a preliminary procedure before heart catheterization and for the evaluation of residual shunts after reconstructive cardiac surgery. The external recordings may also prove valuable for localization of shunts during heart catheterization. (auth)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 17467, 17659, 17660, 17662, 18171, 18180, 18261, 18271, 18426, 19654, 19659, 19715, 19716, 19719, and 19873.

18108 (AD-731375) I. NEW METHODS OF SYNTHESIS OF MATERIALS. II. THE PROPERTIES OF RARE EARTH METALS AND ALLOYS. Semiannual Technical Report No. 2, March 1–July 31, 1971. Bunshah, R. F.; Douglass, D. L. (California Univ., Los Angeles. School of Engineering and Applied Science). 1 Sep 1971. 70p. (UCLA-ENG-7161). NTIS.

The high-rate physical vapor deposition (HRPVD) process was used for the synthesis of compounds Y_2O_3, TiC, Si_3N_4 by reactive evaporation and their characterization. The oxidation kinetics of Ni–20Cr containing nominally 1% of Y, Gd, or La have been evaluated over the range of 900 to 1200°C in static air. The nature of the oxide films formed and the disposition of the rare earth additions have been evaluated by x-ray diffraction and electronmicroprobe analyses. (NTIS)

18109 (AECL-3862) OXIDATION, HYDRIDING, AND AQUEOUS CORROSION OF U_3Si ALLOYS. Feraday, M. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1971. 36p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

Specimens of U_3Si were heated in air and in hydrogen at temperatures up to 550°C and the products of reaction studied. The phases observed in these tests are compared with those which form in U_3Si samples corroded in high temperature water. The aqueous corrosion of U_3Si is mainly an oxidation reaction although limited hydriding may also occur as a secondary reaction. The oxidation of U_3Si either in air or water appears to be a multistep process in which most of the phases of the uranium-silicon system form. Due to the kinetics of formation and stability of the phases at various temperatures all are not observed in an individual test. Although molecular hydrogen will not react with U_3Si directly, in some cases it will react with free uranium to form UH_3. If the UH_3 is subsequently oxidized, nascent hydrogen will be released which will react with the U_3Si. (auth)

18110 (AED-CONF-71-100-27) PREPARATION AND PROPERTIES OF LOWER DENSITY UO_2 PELLETS. Assmann, H. (Siemens A. G., Erlangen (West Germany)); Kroll, H.; Roepenack, H. May 1971. 18p. (CONF-710901-525). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies on low-density UO_2 pellets showed that three methods will produce pellets with the required density range between 9.8 and 10.3 g/cm^3. These methods are: UO_2 powder with reduced sintering activity; UO_2 powder with UO_2 returns; and UO_2 powder with the addition of ammonium uranyl carbonate. Pellets produced by the first two methods had a large percentage of open pores, while those of the last method all had closed porosity. On isothermal annealing, the percentage of open pores of the first two methods decreased or disappeared. The structures from the three methods differed in a characteristic manner in respect of pore size distribution and pore morphology. On plastic deformation the major part of the porosity remained available for matrix swelling. (P.C.H.)

18111 (AERE-M-2408) PREPARATION OF URANIUM MONOCARBIDE SPHERES BY CARBOTHERMIC REDUCTION OF SOL-GEL URANIUM OXIDE–CARBON SPHERES. Hyde, K. R. (Atomic Energy Research Establishment, Harwell (England)). Jun 1971. 7p. Dep. NTIS (U. S. Sales Only).

Uranium carbide spheres of 60 to 120 μ diameter and >95% of theoretical density were made in batches of ≥50 g. A mixture of a UO_2 sol and carbon was spheroidised in Alphanol (a long-chain alcohol) and the gel spheres were washed and dried, and finally converted to UC in argon-fluidised bed with temperature programming up to 1650°C. The product was predominantly UC with about 0.1 wt.% oxygen. (auth)

18112 (ANL-Trans-904) REACTIONS BETWEEN CLADDING (STAINLESS STEEL) AND FUEL (MIXED OXIDE $(U,Pu)O_{2+x}$ DURING IRRADIATION IN FAST REACTORS. de Keroulas, Francois; Le Beuze, Robert; Calais, Daniel; Marcon, Jean Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by Dennis O'Boyle from Fall Meeting of the French Society of Metallurgy, Paris, September 1971. 21p. (CONF-710943-1). Dep. NTIS.

During the operation of a fast reactor, fission causes oxidation of the $(U,Pu)O_{2+x}$ fuel. For a certain value of x, which is a function of the composition of the steel, thermodynamic analyses results indicate oxidation of the cladding material by the fuel. This reaction is limited by the very low mobility of chromium and oxygen in ferritic-type oxides (mainly oxides of chromium of the type $(CrFe)_2O_3$) that form at the cladding-fuel interface. This reaction can take place however by means of the volatile fission products as well as by internal stresses due to swelling of the fuel and the high temperature that causes fissuring in the contacting oxide layer. Tellurium reacts with the steel to form a phase rich in chromium and in manganese (19 and 6 wt % respectively). This results in a superficial surface dechromization of the steel that reduces its resistance to oxidation. Iodine causes a transport phenomena in the vapor phase. Cesium iodide (a combination of fission products) attacks the grain boundaries of the steel and gives up cesium to react with iron and chromium. The iodide thus formed migrates toward the hot parts, and there decomposes in the fuel at a location where the temperature is near 900°C. These conclusions are based on simulation tests using either annealed diffusion couples of $(U,Pu)O_{2+x}$ vs. stainless steel in a controlled atmosphere or annealed stainless steel in a temperature gradient in the presence of cesium iodide (the iodide and the cesium in varied proportions). Reactions between stainless steel and tellurium (liquid and gas) and results of examinations of highly irradiated fuel elements were also considered. The techniques used are x-ray microanalysis, metallography, and for the x-rays that were produced it was necessary to recalculate the x-rays owing to the influence of highly radioactive plutonium base materials (alpha emitters) or irradiated materials (beta and gamma emitters). (auth)

18113 (COO-1198-856) INVESTIGATION OF THE GROWTH OF TUNGSTEN CARBIDE SINGLE CRYSTALS IN VACUUM BY A MODIFIED CZOCHRALSKI TECHNIQUE. Baldoni II, Joseph Gary (Illinois Univ., Urbana). Sep 1971. Contract AT(11-1)-1198. 48p. Dep. NTIS.

Attempts were made to grow large α-WC single crystals under vacuum conditions. It was believed that crystal growth under this condition would produce α-WC single crystals with even lower defect concentration than those studied by others, such that oscillatory measurements (de Hau-van Alphen, etc.) could be performed. A better crucible material was also sought. The results showed that high quality WC single crystals cannot be grown in vacuum by the modified Czochralski technique using Co as a flux material. However, calcia-stabilized zirconia appeared to be an adequate crucible material for containing molten WC–Co alloys in vacuum. (P.C.H.)

18114 (EUR-4613) PHYSICO-CHEMICAL STATE OF FISSION PRODUCTS IN IRRADIATED MIXED OXIDE $(U,Pu)O_2$ FUELS. Camozzo, G. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1971. 46p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 6,65.

A survey of current knowledge of the physicochemical state of fission products in fuels based on UO_2 oxides and UO_2–PuO_2 mixed oxides after irradiation is presented. Particular attention has been devoted to high burnup fuels obtained from fast reactors. Generally speaking, it may be concluded that in a strongly irradiated fuel the fission products are localized in distinctly characteristic zones, either in the form of metallic inclusions, for example Mo, Ru, Tc, Rh, Pd, or non-metallic inclusions, mainly oxides rich in Ba and accompanied by other elements such as Ce, Sr, Nd, or in solid solution in the matrix, as is the case for the oxides of Zr, Ce, La, Nd, Pr, etc. The chemical state of various fission products was examined in relation to the oxygen balance and thermodynamic considerations of the fuel. Physical aspects of the irradiated fuel such as its crystallographic structure, the distribution of Pu, the diffusion of fission products, and influence of the sheath were also studied and are discussed. (auth)

18115 (FRNC-TH-131) DEVELOPMENT OF AN ELECTRON BOMBARDMENT FURNACE, STUDY OF Ti, Zr, AND Hf DIBORIDES. Favre, Raymond (Lyon Univ. (France)). 1971. 89p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

An electron bombardment furnace was developed to study refractory compounds. The furnace was tested by studying the fusion of B and Zr and the purification of Zr. The diborides of Ti, Zr and Hf were prepared by reduction of the corresponding metallic di-

oxides using boron. Physicochemical properties of these compounds were studied. (France)

18116 (GEAP-12229) THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 16, May 1, 1971–July 31, 1971. Aitken, E. A.; Adamson, M. G.; Evans, S. K.; Ludlow, T. E. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Jul 1971. Contract AT(04-3)-189. 23p. Dep. NTIS.

Developments are reported in the continuing scope of work related to vaporization of urania in urania–plutonia solid solutions, oxygen activities at high temperatures, oxygen redistribution in a temperature gradient, Pu/U segregation, and sodium-fuel interactions. (auth)

18117 (GEAP-13733) THERMAL CONDUCTIVITY OF URANIUM–PLUTONIUM OXIDE. Laskiewicz, R. A.; Evans, S. K.; Melde, G. F.; Bohaboy, P. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Sep 1971. Contract AT(04-3)-189. 76p. Dep. NTIS.

Out-of-pile thermal conductivity measurements were made on urania–plutonia fuel mixtures for varying fuel temperature, density, stoichiometry, composition, and fabrication method. The measurements were made in a helium–6% hydrogen atmosphere using a radial heat flow technique. The empirical equation developed for the thermal conductivity of $(U_{0.8}Pu_{0.2})O_{2-x}$ is: $k = 0.01524 + \{1/(0.9702 - 0.4465D)T\} + 0.5841 \times 10^{-12}T^3 + \{360.2/(2.04 - O/M)T^2\}$ where k = thermal conductivity (watts/cm-°C), T = temperature (800-2300°C), D = fractional density (0.84 – 0.91) and O/M = stoichiometry (1.94 – 2.00). Values for k on this curve, (for D = 0.91, Pu/(U + Pu) = 0.2 and O/M = 2.00) range from 0.0318 W/cm-°C at 800°C to 0.0248 W/cm-°C at 2300°C. The equation was obtained using a weighted non-linear regression analysis. Data above ~1800°C indicated that the thermal conductivity increased slightly above this temperature. The results are in good agreement with previously published data. Error analyses inherent in the regression technique used showed that the equation has 90% confidence limits of ±11% which reflect the experimental and curve fitting errors involved in its development. (auth)

18118 (IS-2600, pp 1-8) CERAMIC ENGINEERING DIVISION. (Ames Lab., Iowa). Dec 1971.

In Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1970–June 1971.

Research progress is reported on stability of HfO, thermal properties of materials, thermal conductivity of ceramic materials, diffusion in fluorite structure ceramics, diffusion in MgO, interdiffusion in rare earth oxides, and oxidation of rare earth metals. (J.R.D.)

18119 (JUL-795-RW) STRUCTURE OF PROPENE–PYROCARBON COATING LAYERS ON COATED FUEL PARTICLES AND THEIR CHANGE BY HEAT TREATMENT. Gyarmati, E.; Koizlik, K.; Gupta, A. K. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Sep 1971. 26p. (In German). Dep. NTIS (U. S. Sales Only).

For an irradiation experiment $(U,Th)O_2$-kernels were coated with pyrocarbon of different density and orientation anisotropy. The deposition of pyrocarbon was carried out with propylene, C_3H_6. In order to get information on the alteration of the structure of the coatings before the irradiation, the particles were heat treated. As a consequence of the heat treatment the orientation anisotropy of pyrocarbon increased. The rapid growth of the orientation anisotropy can be explained by the generation of strong stresses having long ranges in the pyrocarbon coating. A density range of approximately 1.7 gcm^{-3} existed in which there appeared only very small anisotropy increases by heat treatment below 2000°C. An increase in anisotropy was higher in case the anisotropy of the starting material increased and its apparent crystallite size decreased. (auth)

18120 (LA-4856) HIGH-TEMPERATURE EVALUATION OF Mo–Tm_2O_3 CERMET. Keddy, Edward S. (Los Alamos Scientific Lab., N. Mex.). Jan 1972. Contract W-7405-eng-36. 3p. Dep. NTIS.

Molybdenum and tungsten-coated 60 : 40 vol % Mo–Tm_2O_3 cermet samples, evaluated at 1700°C for 1000 h, displayed no dimensional changes and suffered only minor weight losses. These losses, which are due to Tm_2O_3 surface evaporation, might be prevented by thicker coatings. (auth)

18121 (LA-DC-12734) EFFECT OF FAST NEUTRON IRRADIATION ON CERAMICS AND CERAMIC–METAL SEALS. Reichelt, W. H.; Backus, C. E.; Patrick, A. J.; Ranken, W. A. (Los Alamos Scientific Lab., N. Mex.). [1971]. Contract W-7405-eng-36. 12p. (CONF-711038-1). Dep. NTIS.

From IEEE thermionics conversion specialist conference; San Diego, Calif. (4 Oct 1971).

Specimens of yttria, high-grade alumina, and ceramic-to-metal seals were irradiated in the EBR-II reactor at a temperature of 750°C to a peak neutron fluence of $\sim 4.6 \times 10^{21}$ nvt ($E_n > 0.1$ MeV). Three types of alumina were included in the test capsule: Lucalox (GE), AD-999 (Coors), and E-37 (Feldmuehle). The ceramic-to-metal seals represented V–Nb brazed Nb/Al-995, Cu–Ni brazed Ni/E-37, and autoclave-bonded Nb–1%Zr/E-37 seals. Postirradiation measurements indicated that volume swelling in Al_2O_3 appears to be a function of grain size and/or of the impurity levels. These results are in agreement with previously reported data. Y_2O_3 displayed no swelling. Metal-to-ceramic seal assemblies swelled but remained vacuum-tight at these fluences. The thermal conductivities of irradiated Y_2O_3 at 750°C was ~70% of that of highly irradiated alumina. (auth)

18122 (SC-DR-710789) PREPARATION OF METAL HYDRIDES OF WELL-DEFINED COMPOSITION, USING THE SIEVERTS TECHNIQUE. Begeal, D. R. (Sandia Labs., Albuquerque, N. Mex.). Jan 1972. 22p. Dep. NTIS.

The capability to prepare metal hydrides of a well-defined composition has been developed. The capability utilizes the stoichiometric reaction of hydrogen with the metal in a Sieverts apparatus. Two set-ups are available to supply specimens for hydride research at Sandia Laboratories. One system is designed to prepare tritides, and the other system will prepare hydrides or deuterides. Both systems are in operation at GEND. Each apparatus is designed so that the specimen temperature and the hydrogen pressure can be controlled during the hydrogen-metal reaction, thereby controlling the rate of the reaction. It is, therefore, possible to prepare a specimen of a preselected composition, provided that the specific phase region and concentration can physically exist. It is also possible to maintain the structural integrity of the specimen in concentrations up to 2.0. A description of the apparatus, the hydriding procedure, and the types of hydrides that can be prepared is given. Also included is a discussion on sample size, accuracy of concentration, and the special procedures required for specific types of hydrides. (auth)

18123 (WHAN-IR-45) INSTRUCTION FOR THE SELECTION AND USE OF ACCEPTANCE SAMPLING PLANS. Stevenson, W. F. (WADCO Corp., Richland, Wash.). Nov 1970. Contract AT(45-1)-2170. 60p. Dep. NTIS.

The instruction serves as a standard which describes basic principles which must be considered in the selection and use of acceptance sampling plans involved in procurement of FTR fuels and components. (J.R.D.)

18124 GROWTH MECHANISM OF ANODIC OXIDES STUDIED BY CURRENT DECAY. Fritzsche, Christian R. (Institut fuer Elektrowerkstoffe, Freiburg i. B.). Z. Phys. Chem. (Leipzig); 248: No. 3-4, 145-51(1971).

Current decay at constant voltage after anodization can be described by the Mott–Verwey theory of ion migration as well as by the impact ionization theory, both having a hyperbolic approximation. While the decay constant is inversely proportional to the forming voltage in the case of the Mott–Verwey theory it does not depend upon voltage in the case of the impact ionization theory. A decay law that takes into account both theories is derived. Experimental values of the decay constant show that tantalum oxide obeys the Mott–Verwey theory whereas the impact ionization theory is valid for silicon dioxide. For aluminum oxide both the decay constant and their voltage product depend upon voltage. The current dependence of anodization efficiency indicates that impact ionization possibly contributes to the growth of aluminum oxide. The influence of surface preparation on decay curves and efficiency of growth was studied with tantalum and aluminum. (auth)

18125 FLUX GROWTH OF V_2O_3 SINGLE CRYSTALS BY REDUCTION OF V_2O_5 IN A GRAPHITE CRUCIBLE. Foguel, M.; Grajower, R. (Hebrew Univ., Jerusalem). J. Cryst. Growth; 11: No. 3, 280-2(Dec 1971).

V_2O_3 single crystals were grown in a Stockbarger furnace in an argon atmosphere, by the reduction of V_2O_5 in molten KF. Graphite served both as crucible material and reducing agent. The crystals obtained were of good stoichiometry, high purity and measured up to 6.5 mm across and over 2 mm thick. (auth)

18126 ACID PROPERTY OF TITANIA–ZIRCONIA. Shibata, Katsue; Kiyoura, Tadamitsu (Mitsui Toatsu Chemicals, Inc., Yokohama, Japan). J. Res. Inst. Catal., Hokkaido Univ.; 19: No. 1, 35-41(Apr 1971).

The acidity distribution of TiO_2-ZrO_2 catalysts with various amounts of ZrO_2 content was measured by n-butylamine titration using Hammett indicators. It was found that the acid amount and acid strength of TiO_2-ZrO_2 with a molar ratio of 1:1 are largest and highest. The acid amounts were 0.34, 0.57, and 0.65 mmole/g at $H_0 = -8.2, -5.6, -3.0$, and +4.0, respectively. The mixed oxides which show such a remarkable acid property were found to be amorphous by means of DTA, x-ray analysis, and surface area measurement. The catalysts were prepared by thermal decomposition of co-precipitated mixtures which were made by two different methods: by the addition of ammonia and by the addition of urea. The acid strengths of the catalysts did not depend on the method of preparation of the co-precipitate, but the acid amount was higher in the sample precipitated by urea than in the sample precipitated by ammonia. (auth)

18127 EFFECT OF CERTAIN CARBIDES ON THE KINETICS OF THE REDUCTION OF NICKEL(II) OXIDE BY HYDROGEN. Samsonov, G. V.; Klimak, Z. A. (Inst. of the Problems of Materials Science, Kiev). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 7, 968-9(Jul 1971).

Translated from Zh. Fiz. Khim.; 45: No. 7, 1712-14(Jul 1971).

The effects of the addition of transition metal carbides (ZrC, NbC, Mo_2C) on the kinetics of the reduction of nickel(II) oxide by hydrogen has been investigated. The carbides have an accelerating effect on the reduction of the oxide owing to their electron-donating properties. (auth)

18128 GROWTH OF SINGLE CRYSTAL YB_{66} FROM THE MELT. Oliver, D. W.; Brower, George D. (General Electric co., Schenectady, N. Y.). J. Cryst. Growth; 11: No. 3, 185-90 (Dec 1971).

Cubic YB_{66} has been synthesized in quantity and pulled as crystal boules from water-cooled copper boats. Crystals of good quality have been grown by the pedestal technique. Interaction of the melt with refractories, crystal purity, and the B-Y phase diagram in the vicinity of YB_{66} are reported. (auth)

18129 [PREPARATION AND] SOME PROPERTIES OF THIN FILMS OF THE NITRIDES OF VANADIUM, TITANIUM, TANTALUM, AND NIOBIUM. Synorov, V. F.; Kryachko, V. V.; Strilets, M. M.; Lebedev, E. A. Tr. Voronezh. Gos. Univ.; 74: 65-8(1971). (In Russian).

A description is given of the preparation of films of nitrides of some transition metals (V, Ti, Ta, and Nb) using reactive ion plasma deposition. The individual electro-physical properties were studied. (Referativnyi Zh.)

18130 COMPARISON OF THE REFINING EFFECTS OF ARC- AND ELECTRON BEAM MELTING OF ZIRCONIUM. Stojsic, I.; Cvetanovic, D.; Obradovic, N. (Inst. for Technology of Nuclear and Other Mineral Raw Materials, Belgrade). Bull. Soc. Chim. Beograd; 35: No. 9-10, 505-16(1970). (In Serbo-Croatian).

During arc-melting only some of the metallic impurities are removed. The method can only be used for sponge consolidation. Electron-beam melting has a strong refining effect, e.g., hydrogen content is drastically reduced and that of nitrogen and oxygen to some extent. The number of partially removed metallic impurities is greater than with arc melting, and their final concentrations are lower. (Editor)

18131 LATTICE THERMAL CONDUCTIVITY AT HIGH TEMPERATURES. Billard, D.; Cabannes, F. (CNRS, Orleans, France). High Temp. - High Pressures; 3: No. 2, 201-12(1971). (In French).

The most reliable experimental data on the thermal conductivity λ of the oxides Al_2O_3, BeO, and MgO were examined. It was found that the results cannot be interpreted on the assumption of linear variation of umklapp resistivity with temperature, in the temperature range where it was necessary to adopt the high-temperature approximation for the lattice conductivity. As in the case of Ge and Si, the experimental results for the oxides were well fitted by a parabola $\lambda^{-1} = aT + bT^2 + c$, the theoretical justification of which was provided by a 4-phonon umklapp process. (auth)

18132 LATTICE PARAMETERS AND THERMAL EXPANSION COEFFICIENTS OF CdO BETWEEN 40 AND 1300°K. VACANCY STRUCTURE OF THE OXIDE. Straumanis, M. E.; Vora, P. M.; Khan, A. A. (Univ. of Missouri, Rolla). Z. Anorg. Allg. Chem.; 383: No. 2, 211-19(Jul 1971). (In German).

The influence of excess Cd in CdO on the lattice parameter, color, and density was explored. Eight samples were prepared by various methods and the lattice parameter determined. The oxides, showing no excess of Cd (as tested with $KMnO_4$) all had nearly the same $a_{25} = 4.6951 \pm 0.0002$ Å. The color of the samples varied from reddish brown to black; however, in transmitted light at high microscopic magnification, all of them appeared red. These and other facts led to the conclusion that Cd, if dissolved at elevated temperatures in CdO, segregates to a certain degree upon cooling. Hence, the lattice parameter increase due to solubility of Cd in CdO had to be subtracted from the total to obtain the pure thermal expansivity; a straight line relationship between 300 and 1000°K resulted with $\alpha = 1.15 \times 10^{-6}$ deg^{-1}. α began to decrease below 300° and became zero at 40°K. The density of the CdO heated in air was larger (99.67% of the theoretical 8.2375 g/m^{-3} at 25°C) than that of the excess Cd containing oxide, indicating the presence of vacancies in larger amounts in the latter preparation. (auth)

18133 STABILITY OF SODIUM-BONDED ACTINIDE CARBIDES IN TYPE 316 STAINLESS STEEL CONTAINERS. Litton, F. B.; Wallace, T. C. TMS Paper No. A71-89. New York; American Institute of Mining, Metallurgical, and Petroleum Engineers (1971). 28p. $3.00.

The reaction of Na-bonded actinide carbides with Type 316 stainless steel was investigated at 450 to 750°C for time periods to 8000 h. Carbon was not transported from single-phase, H-reduced uranium-plutonium carbide but was transported from hyperstoichiometric actinide carbides to 316 stainless steel containers. Estimates of the chemical activity of C in the actinide carbides and in the carbide formed in the container material were in agreement with the experimental results. This agreement suggests that estimates of the chemical activities of the components should be prime criteria for the selection of materials for use in systems in which carbides are present. The σ phase was observed in uncarburized 316 stainless steel containers heated to 550°C and higher temperatures. The formation of the σ phase and the enrichment of the matrix phase with Ni caused a Pu-Ni intermetallic compound to form between the single-phase uranium-plutonium carbide and the 316 stainless steel container after 8000 h at 750°C. (30 references) (Metals Abstr.)

18134 CRYSTALLOGRAPHIC SHEAR IN $WO_3 \cdot xNb_2O_5$ (x = 0.03 TO 0.09). Allpress, J. G. (Univ. of Melbourne, Parkville, Australia). J. Solid State Chem.; 4: No. 2, 173-85(Mar 1972).

Tungsten trioxide samples doped with 3 to 9 mole % of niobium pentoxide have been examined by electron diffraction and microscopy. The effect of the dopants is to introduce crystallographic shear (CS) planes, which lie parallel to $\{100\}_R$, $\{410\}_R$, and $\{210\}_R$ (R = ReO_3-type parent lattice), depending upon the composition. Idealized models for these CS structures are suggested, and the results are discussed in terms of the relative stability of various possible structures, and the formation and diffusion of CS surfaces. (auth)

18135 HIGH-TEMPERATURE PHASE DIAGRAM OF THE SYSTEM $La_2O_3-Yb_2O_3$. Rouanet, Alain; Coutures, Juliette; Foex, Marc (CNRS, Odeillo, France). J. Solid State Chem.; 4: No. 2, 219-22(Mar 1972). (In French).

The high temperature phase diagram $La_2O_3-Yb_2O_3$ has been studied from 1400°C to the melting point, all together by direct thermal analysis and by x-ray diffraction. A cubic solution largely extending from La_2O_3 near to Yb_2O_3 was observed at the melting point. The $LaYbO_3$ perovskite-type compound which appears below 2040°C is surrounded by two eutectoids. (auth)

18136 RHENIUM-OXYGEN SYSTEM AT HIGH PRESSURE: STRUCTURE AND CHARACTERIZATION OF A NEW RHENIUM OXIDE. Jeitschko, W.; Sleight, A. W. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Solid State Chem.; 4: No. 2, 324-30(Mar 1972).

The rhenium-oxygen system has been studied under 65 kbar pressure. In addition to the known ReO_2, ReO_3, and Re_2O_7 phases, a new, nonstoichiometric phase has been found. This phase can be represented as $Re_{1+x}O_3$ where values of x from 0.14 to 0.21 have been observed. The structure of this new phase has been determined for x = 0.16. The space group is $P6_322$, and the hexagonal cell dimensions are a = 4.8350 ± 0.0006 Å and c = 4.5350 ± 0.001 Å. The structure is based on hexagonally close-packed oxygens with rheniums in certain of the octahedral sites. Crystals of this new rhenium oxide show metallic conductivity. The relation of the $Re_{1+x}O_3$ structure to other structures with hexagonal close-packed anions is discussed. (auth)

18137 CLEAVAGE FRACTURE OF VC MONOCRYSTALS. Govila, R. K. (Martin Marietta Corp., Baltimore). Acta Met.; 20: No. 3, 447-57(Mar 1972).

The mechanical behavior of VC monocrystals of a range of stoichiometries has been studied below their brittle-to-ductile transition temperatures where the mechanical properties are relatively independent of dislocation movement. The cleavage surface energy, γ, and the critical transition temperature, T_c,

corresponding to the onset of some dislocation mobility, were measured for VC monocrystals as a function of composition and temperature. A preliminary attempt has been made to show that the nature of ordering in VC determines the fracture strength. Cleavage cracks on (001) planes of VC monocrystals were introduced by microhardness indentation of the (110) planes. Precracked specimens were loaded to failure in three or four points bending at 20°C. The fracture stress, σ_F, was dependent on crack length according to the Griffith criterion. The temperature dependence of σ_F for specimens containing cracks of approximately similar length was determined between 20 and 1300°C. It was found that σ_F remained essentially constant from 20 to 1000°C for $VC_{0.88}$, to 1160°C for $VC_{0.84}$ and to 800°C for $VC_{0.76}$, demonstrating the extremely low mobility of dislocations in this material; above T_c, σ_F for $VC_{0.84}$ and $VC_{0.76}$ were of similar magnitudes but several times higher than in $VC_{0.88}$. This increase is believed to be due to the nature of ordering. The increase in σ_F above T_c due to the movement of dislocations supports the hypothesis that the mobility of dislocations in VC is thermally activated. The similarities observed in the deformation and fracture behavior of $VC_{0.84}$ and $VC_{0.76}$ strongly support the presence of either long-range or short-range ordering in $VC_{0.76}$ monocrystals. (auth)

18138 PHASE TRANSFORMATIONS IN CONCENTRATED V–N SOLUTIONS. Potter, D. I.; Altstetter, C. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Acta Met.; 20: No. 3, 313-18(Mar 1972).

The internal structure and crystallography of banded microstructures occurring alloys of vanadium containing from 6 to 12 at. % nitrogen have been investigated by electron and x-ray diffraction, optical and transmission microscopy, and two-surface analyses. In this composition range the vanadium atoms existed in at least two phases, one of which was body centered tetragonal and the other hexagonal. Both phases coexisted within a given band with the tetragonal phase in the majority and forming the matrix. This caused a fine structure internal to each band. The hexagonal phase was oriented with its basal plane normal to the tetragonal axis of matrix and with $[11\bar{2}0]/[010]$. Its parameters were a = 2.14 Å and c/a = 2.4. The tetragonal phase parameters varied linearly with composition with c = 3.00 Å, a = 3.08 Å for a 7.4% alloy and c = 2.97 Å, a = 3.11 Å for a 10.0% alloy. Adjacent bands were twin related across a $\{101\}$ twin plane of the tetragonal lattice while alternate bands had the same orientation. A large scale deflection of the wire sample as well as audible clicking sounds accompanied the transformation. The significance of the present findings is discussed in relation to other systems exhibiting such banded microstructures. (auth)

18139 ABSORBERS FOR NUCLEAR REACTORS USING PLASMA SPRAY TECHNIQUES. Noden, J. D.; Knights, C. J. (Berkeley Nuclear Labs., Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 1, 49-58(Jan 1972).

The problems of control of nuclear reactors have increased due to the advance to higher power densities and more onerous environments, e.g. increased pressure, temperature and corrosion aspects. In addition geometrical difficulties can arise owing to differential thermal movements of in-core components, and various possible developments are suggested to satisfy these conditions. The use of plasma spray techniques for the manufacture of absorber tubes is discussed in detail and the extensive mechanical and thermal development work described. Other features, such as the use of absorber loaded ceramics, are considered as useful lines of approach, particularly to the high temperature reactors (Mark III). (auth)(UK)

18140 VOLUME AND STRUCTURE CHANGES DURING SINTERING AND ISOTHERMAL ANNEALING OF SINTERED URANIUM DIOXIDE PELLETS. Landspersky, Hanus (Nuclear Research Inst., Rez, Czech.). Jad. Energ.; 18: No. 2, 45-53 (Feb 1971).

UO_2 pellets presintered at temperatures between 1300 and 1600°C were heated between 1300 and 2200°C for studying the volume and structural changes in them. At temperatures between 1300 and 1600°C, the shrinkage proceeded according to the models proposed by Coble. At higher temperatures, discontinuous grain growth was observed that influenced considerably grain growth. The power law for the grain growth was applied for the evaluation of structural changes, but the value of the exponent was higher than that derived theoretically. The addition of binders influenced both the grain growth and the homogeneity of the sintered and annealed material. (auth)

18141 UNCERTAINTY IN THE HEAT CONDUCTIVITY OF UO_2 AS A FUNCTION OF TEMPERATURE. Mueller, E.-M. (INTERATOM, Bensberg, Ger.). Atomwirt., Atomtech.; 17: No. 1, 37-8(Jan 1972). (In German).

The heat conductivity of UO_2 was investigated by means of a "round-robin" program involving nine different laboratories and various measurement techniques but using samples from the same preparation of UO_2. The temperature range of interest was about 400 to 2800°C. The heat conductivity curve showed a minimum at about 1700°C; above this temperature the fluctuation range was high and reflected the uncertainty and difficulty of high temperature measurements. (K.S.W.)

18142 CARBIDE SYNTHESIS BY FREEZE-DRYING. Roehrig, F. K.; Wright, T. R. (Battelle Columbus Labs., Columbus, Ohio). J. Amer. Ceram. Soc.; 55: No. 1, 58(Jan 1972).

The use of the freeze-drying process for the generation of fine tungsten carbide powders is described. The chief advantages of the process over more conventional powder synthesis methods are the generation of ultrafine particles and control of composition and purity. Ultrafine WC and W_2C were prepared by freeze-drying a suspension of colloidal graphite in an ammoniacal tungstic acid solution. The solution-suspension was frozen rapidly to retain in the solid state the almost ideal mixing that existed in the liquid state and freeze-dried to remove the solvent. The resultant WO_3 was reduced using high-purity H_2; the resulting intimate mixture of W and C was reacted in vacuum at 1500°C for 30 min to form the carbide. (P.C.H.)

18143 REVISED WEIGHT CHANGE IN NONSTOICHIOMETRIC ZrO_2. Tripp, Walter C. (Systems Research Labs., Inc., Dayton, Ohio); Tallan, Norman M. J. Amer. Ceram. Soc.; 55: No. 1, 60(Jan 1972).

Thermogravimetric data for ZrO_2 published previously (R. W. Vest, et al., J. Amer. Ceram. Soc., 47; 12, 635-40(1964)) and W. C. Tripp, et al., Vacuum Microbalance Techniques, Vol. 4, pp 141-57, edited by P. M. Waters, (1965)) has been found to be incorrect. Using more precise thermogravimetric equipment and ZrO_2 powder (spectrographic grade) of considerably greater purity than that used previously, weight change was measured for disks weighing ≈4g. The total weight change observed never exceeded ≈10 μg. On the basis of these latest results, the previously reported weight changes were at least an order of magnitude too large. The revised magnitudes of weight change in ZrO_2 do not affect the previous conductivity results, but do influence their interpretation. (P.C.H.)

18144 FRACTURE ENERGIES OF CERAMICS. Swanson, Gerald D. (Midwest Research Inst., Kansas City, Mo.). J. Amer. Ceram. Soc.; 55: No. 1, 48-9(Jan 1972).

The double-cantilever-beam (DCB) test was used to determine fracture energies of ceramics, such as Al_2O_3, SiC, $MgAl_2O_4$, and graphite. In Al_2O_3, as grain size increased (at least from 3 to 45 μm), the cleavage steps in the transgranular areas became larger and the river patterns longer. When impurities were present, the grain boundaries on the fracture surface became rounded and less well defined, and the fracture surface became more complex, with fewer large, smooth areas of intergranular separation. The $MgAl_2O_4$ fracture surfaces contained typical brittle fracture cleavage steps and river patterns. Surface texture was somewhat apparent on the intergranular fracture surfaces. The $CaZrO_4$ additive did not alter the fracture surface noticeably. The SiC fracture surface features included river patterns, cleavage steps, and tire tracks. River patterns with rounded ridges were abundant in graphite. (P.C.H.)

18145 CARBON THERMAL DIFFUSION IN THE UC_2–C SYSTEM. Gulden, T. D. (Gulf General Atomic Co., San Diego, Calif.). J. Amer. Ceram. Soc.; 55: No. 1, 14-18(Jan 1972).

Alpha uranium dicarbide disks coated with pyrolytic carbon migrate, relative to the carbon, up a temperature gradient, leaving behind a layer of rejected graphite. A model for the migration process based on solution of carbon at the hot UC_2–C interface, transport across the UC_2 phase by thermal diffusion, and rejection as graphite at the cool UC_2–C interface was developed. The rate of migration may be described by: $(dx/dt) = [\Omega_c n_c D_c^* Q^*(T)/RT^2]\,(dT/dx)$. The apparent activation energy for migration is 76.5 ± 9 kcal/mole, compared to a literature value for carbon self-diffusion in α-UC_2 of 90.2 kcal/mole. This difference in temperature dependence may be considered preliminary evidence that the heat of transport decreases with increasing temperature. The average value of the heat of transport, calculated using literature values for carbon self-diffusion in α-UC_2, is 92 ± 27 kcal/mole. (auth)

18146 GAS-FLAME APPLICATION OF OXIDE COATINGS. Pirogov, Yu. A.; Svirskii, L. D. (Kharkov Polytechnic Inst.). Zashch. Metal.; 6: No. 3, 371-3(May-Jun 1970). (In Russian).

An oxy-acetylene flame was used to apply Al_2O_3 and ZrO_2 powders as coatings to a metallic support. Particle dimensions were: Al_2O_3–20 to 60 μ and ZrO_2–10 to 35 μ. The degree of deformation of the particles of coating was measured as a function of the dis-

tance between the nozzle and the coated surface, and appeared to to attain a maximum between 50 and 100 mm. A study was also made of the rate of gas consumption and composition of the burning fuel mixture and their effects on the optimum formation of the oxide coatings. (K.S.W.)

18147 EFFECT OF THIOSULFATE ON CHEMICAL NICKEL-PLATING. Prokopchik, A. Yu.; Val'syunene, Ya. I.; Butkyavichyus, Yu. P.; Kimtene, D. P. (Inst. of Chemistry and Chemical Tech., Vilnyus, USSR). Zashch. Metal.; 6: No. 5, 517-21(Sep-Oct 1970). (In Russian).

The mechanism of the stabilizing effect of thiosulfate on the chemical deposition of Ni–B coatings was studied in plating solutions containing $NiCl_2$, NaOH, $NaBH_4$, and $NH_2(CH_2)_2NH_2$. As used at 90°C the deposited Ni coat contained about 6% B. The thiosulfate in solution inhibited the reduction of Ni^{2+} and retarded the unproductive decomposition of borohydride on the surface of the deposit. (K.S.W.)

18148 ACTIVITY OF IRON OXIDES IN SILICATE ENAMELS. Perminov, A. A.; Rodionova, G. P. (Ural Scientific-Research Inst. of Ferrous Metals, Sverdlovsk, USSR). Zashch. Metal.; 6: No. 3, 373-7(May-Jun 1970). (In Russian).

The thermodynamic activity of iron oxides in borosilicate enamels was investigated by the emf method at 900°C : $Fe^-|SiO_2, Na_2O, B_2O_3, FeO, Fe_2O_3|Pt^+$. The initial starting melt consisted of SiO_2–27% Na_2O–25% B_2O_3. The departure from ideality of the activities and activity coefficients is discussed in terms of polymer formation and bonding between oxygen and the metals involved. (K.S.W.)

18149 NEW RHENIUM CARBIDE FORMED BY HIGH-PRESSURE TREATMENT. Popova, S. V.; Boiko, L. G. (Inst. of High Pressure Physics, Moscow). High Temp. - High Pressures; 3: No. 2, 237-8(1971).

A new rhenium carbide was synthesized at high pressure (≥60 kbar) and high temperature (≥800°C). Preliminary chemical analysis showed that it is probably the monocarbide of rhenium. It has a structure of γ'-MoC type (space group $D^1_{3h} = P\bar{6}_3/mmc$, z = 4) with the following parameters for the hexagonal unit cell a = 2.840 ± 0.001 Å, c = 9.85 ± 0.01 Å; c/a = 3.47. At atmospheric pressure rhenium carbide decomposes at 1500°C into a rhenium-carbon solid solution. The superconducting properties of rhenium-carbide were studied up to 1.6°K but no superconducting transition was observed. (auth)

18150 INFLUENCE OF THE BASICITY OF ENAMEL ON ITS ADHESION TO STEEL. Perminov, A. A.; Rodionova, G. P. (Ural Scientific-Research Inst. of Ferrous Metals, Sverdlovsk, USSR). Zashch. Metal.; 6: No. 6, 738-40(Nov-Dec 1970). (In Russian).

In connection with a study of enamel adherence to steel the thermodynamic activity of CoO and NiO was studied as a function of the acid-base properties of the enamel. The latter properties were altered by changing the Na_2O/B_2O_3 ratio in the fundamental melt: SiO_2–35 mole % B_2O_3–13.2 mole % Na_2O–2.24 mole % CoO (or NiO). The CoO (or NiO) activity increased with an increase in the B_2O_3 (acidity) content of the melt. As the B_2O_3 increased, the tenacity of the enamel on the sheet steel samples was raised, as judged by the spallation area of enamel resulting from punching a hole in the enameled steel specimen. (K.S.W.)

18151 ADHESION OF SILICATE ENAMELS TO CAST IRON. Zaitsev, A. A.; Zhovnir, A. F. Zashch. Metal.; 6: No. 6, 727-30(Nov-Dec 1970). (In Russian).

The effects of certain activators (the oxides of Co, Mn, Ni, and Cu) on the stability of adhesion of enamel to decarbonized cast iron are discussed. These activators were added to a glass with the composition SiO_2–20 mole % Na_2O–15 mole % B_2O_3–5 mole % CaF_2, and the resulting enamel was applied to the surface of cast iron which had been decarbonized. The activators increased the adhesion of the enamel. However, a definite adhesion was also noted in the absence of the oxide activators both on a cast iron surface which had been roughened by a blast of metal shot and also on carefully polished surfaces. (K.S.W.)

18152 TYPES AND PROPERTIES OF PROTECTIVE COATINGS WHICH CONFER HIGH-TEMPERATURE CORROSION RESISTANCE FOR USE IN GAS TURBINES. I. Gondolf, Erich; Wehr, Herbert. Stahl Eisen; 91: No. 14, 839-41(8 Jul 1971). (In German).

Limitations in the resistance of Ni- and Fe–Cr-base materials to intergranular corrosion, formation of low melting point eutectics etc., and the consequent breakdown of turbine components are discussed in relation to developments in the protection of these components by surface coatings. These coatings give increased resistance to diffusion and erosion and also improve the heat transmission characteristics. Oxide coatings of Al, Cr, Mg, Si, etc. generally provide good oxidation resistance but are often susceptible to attack in other media and have a low thermal-shock resistance. Carbides of B, Cr, Mo, Nb, etc., provide good high temperature corrosion resistance but are often vulnerable to oxidation. Coatings of certain nitrides, borides, silicides, intermetallic phases, metals, and graphite are also mentioned. The factors controlling the bond between base metal and coating are the degree of mechanical inter-linking, the orientation of coating structure relative to that of the substrate, the relative wettability, solubility, and chemical reactivity and diffusivity of coating material into base metal. Ceramic coatings may be applied by spraying, painting, dipping, pouring, and electrostatic precipitation of powder, and are subsequently fritted. (Metals Abstr.)

18153 OXIDATION OF Zr AND Ti DIBORIDES. Toibana, Yasuo (Government Industrial Research Inst., Osaka). Osaka Kogyo Gijutsu Shikenjo Kiho; 22: No. 3, 190-201(Sep 1971). (In Japanese).

The oxidation of hot-pressed ZrB_2 and TiB_2 at temperatures of 700 to 1050°C and at oxygen pressure less than 760 mmHg was studied by oxygen consumption measurements. For ZrB_2, a parabolic oxidation was observed in the experimental range. As the influence of pressure on the reaction rate, the higher oxidation rate was observed at 300 mmHg oxygen pressure in the experimental temperature range. The vaporization of B_2O_3 was obviously a key factor in determining the rate. It was found microscopically that the oxide scale of sample which had been oxidized for 100 h at 1200°C and 760 mmHg oxygen pressure consisted of two clearly distinguishable dense layers, a white outer layer and a black inner one. The oxidation behavior of ZrB_2 is discussed in connection with this dense texture. The activation energy for oxidation of ZrB_2 was about 28 kcal/mole. For TiB_2, both of parabolic and nearly linear oxidation relations depending upon the temperature and oxygen pressure were observed. The oxide scale of TiB_2 oxidized for a long time might consist of three layers, a brown outer layer, a black intermediate one, and a pink inner one, which varied their textures with the respective oxidation behavior. The relationship between the oxidation behavior and the texture was classified into three classes and discussed. The activation energies for the parabolic oxidation were 58 and 35 kcal/mole, respectively, in the region of low temperature and high temperature. (auth) (Japan)

18154 ELECTROCHEMICAL AND CHEMICAL CORROSION OF TUNGSTEN CARBIDE (WC). Voorhies, John D. (Stanford Univ., Calif.). J. Electrochem. Soc.; 119: No. 2, 219-22(Feb 1972).

A potentiostatic-coulometric study was made on the anodic corrosion of WC powder and the cathodic reduction of the surface anode product. Oxidation of WC by the one-electron oxidants ceric sulfate, and ferricyanide is also described. The primary result of the study was the ratio of about 20 between the coulombs required to oxidize a sample of WC anodically and the coulombs for reduction of the anode product. The constancy of this value in 2 N H_2SO_4 under varying conditions of sample size, extent and potential of anode corrosion suggests that there are single anodic and cathodic reactions rather than a multiplicity of poorly defined reactions. Also, for any anodic stoichiometry involving from 2 to 10 electrons per tungsten atom, the cathodic reduction required only 0.1 to 0.5 electrons per tungsten atom oxidized. (P.C.H.)

18155 DEVELOPMENT OF JPDR-II FUEL. Kido, T. (Sumitomo Electric Industries Ltd., Osaka). Genshiryoku Kogyo; 17: No. 9, 20-3(Sep 1971). (In Japanese).

In the JPDR-II project for the Japan Power Demonstration Reactor (BWR) the thermal output will be doubled to 90 MW by employing forced circulation of coolant and redesign of the fuel. Fuel produced domestically with a design fuel burnup of 10,000 MWd/t is to be loaded in December 1971, and the reactor will go into full power operation in March 1972. Tests of fuel assemblies and their irradiation are described. Processes of fuel manufacture for the JPDR-II are outlined and quality control in the fuel production involving UO_2 pellets, Zircaloy-2 cladding tubes, fuel rods, and spacers are discussed. (Japan)

18156 EFFECT ON GRAIN GROWTH OF SINTERED CeO_2 BY TiO_2 ADDITION. Okikawa, Shinji; Somiya, Shigeyuki; Saito, Shinroku (Tokyo Inst. of Tech.). Yogyo Kyokai Shi; 79: No. 914, 365-9(Oct 1971).

Grain growth was investigated in sintered cerium dioxide bodies with and without small amount of titanium dioxide. Temperatures between 1300 and 1550°C were used. When containing titanium dioxide, grain growth approximately followed the equation $D^3 = Kt$. The activation energy for grain growth was deduced to be 75 kcal/mole. In the case of pure cerium dioxide, grain growth followed the equation $D^2 = Kt$, and the activation energy for grain growth above 1450°C was deduced to be 110 kcal/mole. It is sus-

pected that the titanium dioxide affects grain growth of cerium dioxide by the formation of a liquid phase and a new compound of $CeO_2 \cdot 2TiO_2$. (auth) (Japan)

18157 STUDY OF THE MIXED OXIDES OF LANTHANIDES AND VANADIUM(V). Brusset, H.; Madaule-Aubry, F.; Blanck, B.; Glaziou, J. P.; Laude, J. P. (Institut de Chimie, Chatenay-Malabry, France). Can. J. Chem.; 49: No. 22, 3700-7(15 Nov 1971). (In French).

A study of the mixed oxides of vanadium(V) and lanthanides by dry methods, including all elements of the rare earth group except cerium and promethium, was carried out. All orthovanadates of the formula TVO_4 were prepared and their lattice parameters redetermined for all lanthanides. New materials were synthesized: lanthanides $4T_2O_3 \cdot V_2O_5$, where T = rare earth, for elements from samarium to ytterbium the compounds $5T_2O_3 \cdot V_2O_5$ and for praseodymium and neodymium the compounds $6T_2O_3 \cdot V_2O_5$. Identification of these materials was carried out by x-ray diffraction. (auth)

18158 INTERACTION OF NICKEL–CHROMIUM–SILICON–BORON COATINGS WITH [CARBON AND ALLOY] STEEL DURING THE HARDFACING PROCESS. Antonova, E. A.; Andrushchenko, N. S.; Sinai, L. M. Zashch. Metal.; 7: No. 2, 137-42 (Mar-Apr 1971). (In Russian).

Problems arising in connection with the deposition of protective Ni–Cr–Si–B coatings on C or alloy steels by melting a powdered mixture of the original constituents are considered, with special reference to the question of chemical interaction with the underlying metal. The best temperature for this process ensuring continuity of the surface layer, good adhesion, and a minimum of interaction with the substrate, lies at the lower end of the melting range of the powder mixture, namely, 980 to 1050°C. At much higher temperatures, boride eutectics involving the underlying metal tend to develop. (Metals Abstr.)

18159 HEAT CAPACITY OF URANIUM MONONITRIDE. Cordfunke, E. H. P.; Muis, R. P. (Reactor Centrum Nederland, Petten). J. Nucl. Mater.; 42: 233-4(1972).

Heat capacity measurements were made on UN at high temperatures. The results of low-temperature heat capacity data by Westrum and Barber (J. Chem. Phys. 45, 635(1966)) are included. Since there was a smooth continuity between the low-temperature data and high-temperature measurements, it was concluded that the heat capacity of UN is now known over a wide range of temperatures. (P.C.H.)

18160 SOLID-STATE EQUILIBRIA IN THE SYSTEM MgO–Nb_2O_5–Cr_2O_3 AT 1100°C AND 1250°C. Rolando, Piero (Politecnico, Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 105: No. 5-6, 745-57(Sep-Dec 1971). (In Italian).

Solid-state equilibria in the system MgO–Nb_2O_5–Cr_2O_3 were investigated at 1100 and 1250°C. At 1100°C in the zone near to Nb_2O_5, a monoclinic phase was identified corresponding to the formula $(Nb_{11.25}Mg_{0.5}Cr_{0.25})O_{29}$. At 1250°C, the orthorombic modification of this phase is present, which represents the final term of a solid solution (Nb, Mg, Cr)$O_{2.417}$ extending to the join MgO–Nb_2O_5. The stability field of the phase $CrNbO_4$ is partially extended into the ternary system. The solubility of MgO · Nb_2O_5 in Cr_2O_3 · Nb_2O_5 is respectively 13% molecular at 1100 and 22% at 1250°C. (auth)

18161 SIZE FACTOR IN METALLOCERAMIC HARD ALLOYS OF THE TUNGSTEN GROUP. Loshak, M. G.; Fridman, V. M. Probl. Prochnosti; No. 8, 43-7(Aug 1971). (In Russian).

The part played by the size factor in determining the strength and fatigue life of metallocera-ic hard alloys of the W group (e.g., WC–Co) was considered. The possibility of securing very accurate values of the bending strength and fatigue limit of samples with a wide range of geometrical dimensions by using the Weybull relationships, in conjunction with tests on standard-size samples, was demonstrated. Cases in which the size factor may be of vital importance are indicated. (Metals Abstr.)

18162 ORDERED STRUCTURE OF CARBIDES AND NITRIDES OF TRANSITION METALS. Novotnyi, G.; Benezovskii, F. pp 315-23 of Metallovedenie. Moscow; Izdatel'stvo Nauka (1971). (In Russian).

Electron and neutron diffraction methods were used to establish the ordered disposition of C atoms in the crystal structures of transition metal carbides and nitrides, in particular V_2C, Nb_2C, W_2C, etc. The crystal structure of compounds containing transition metals with non-metals showed variations, depending on the type of structure, in the bonding of the octahedral Me_6X groups, where X is the interstitial element, e.g. C in carbides. In such ordered structures the shortest interatomic Me–C distance was shorter than the corresponding Me–hole–Me distance; this is due to a shift of the Me atoms from the ideal position. A strong chemical bond existed between the metal and non-metal atoms. (Referativnyi Zh.)

18163 FIBER-REINFORCED METAL–MATRIX COMPOSITES: 1969–1970. Hanby, K. R. DMIC Rev.; 89p(1 Jul 1971).

Research on fiber-reinforced metal-matrix composites is summarized for Al/B, Al/ductile wire, Al/whisker, Al/C fiber, Ti-base, Mg-base Ni-base and eutectic-type composites. The various programs are described separately. Topics include: the fabrication of Al/B compressor blades; structural airframe applications of advanced composite materials; the reinforcement of Al alloy with epoxy/B; the resistance spot-welding of Al/B; mechanical behavior of composites; Braze-bonded Al/borsic composites; Al/Be lamellar composites; explosive incorporation of Be wires in Al; the effects of deformation and irradiation on composites; fatigue behavior of Al/stainless steel composites; Ti/Be composites produced by coextrusion and the production of Ni-matrix composites by electrodeposition. (Metals Abstr.)

18164 MASS-SPECTROMETRIC DETERMINATION OF THE DISSOCIATION ENERGY OF EuC_2(g). Balducci, G.; De Maria, G.; Guido, M. (Univ., Rome). J. Chem. Phys.; 56: No. 4, 1431-3 (15 Feb 1972).

The vapor phase in equilibrium with condensed europium dicarbide and graphite has been investigated by the Knudsen effusion-mass spectrometric technique over the temperature range 1800 to 2320°K. In addition to europium atoms, the dicarbide molecule EuC_2(g) was identified and its bond and atomization energies were determined: $D_0^\circ(Eu-C_2) = 129 \pm 5$ kcal/mole and $\Delta H_{0,atom}^\circ(EuC_2) = 271 \pm 4$ kcal/mole. (auth)

18165 STUDY ON THE CHANGE OF GRAIN SIZE OF WC POWDER DURING BALL MILLING OF CEMENTED CARBIDE. Kubota, Haruo (Tokyo Tungsten Co. Ltd.); Hara, Akio; Miyake, Masaya. Funtai Oyobi Funmatsuyakin; 18: No. 4, 125-31(Nov 1971). (In Japanese).

The mixing phenomena of WC and Co powders have not yet been made clear enough in spite of their importance. The crushing of WC powders and their grain growth during sintering were examined using various WC powders, i.e., coarse single crystal, coarse polycrystalline, and medium single crystalline WC powders. It was found that coarse single crystal WC powders were crushed markedly by chipping in the early ball milling stage. Thereafter, average grain size of WC continued to decrease with the appearance of fine powders. Therefore, the grain size distribution of the coarse single crystal WC powder grew wider with the increase of ball milling time. Polycrystalline WC powders were crushed in the same way in the early ball milling stage. However, the grain boundary destruction seemed to be caused after having been WC crushed into the definite size. Single crystal WC powder of medium size was more difficult to crush than the coarse powder. The grain growth of coarse single-crystal WC during sintering is more rapid than polycrystalline WC because the size distribution range of the single crystal material is greater. The average grain-size WC formed by medium single crystal WC powders is greater than that from large single crystal material. In sum, the crushability of WC in ball milling and its grain growth in sintering did not only depend upon WC grain size, but also the manufacturing process. (auth) (Japan)

18166 PLASTIC DEFORMATION OF CARBIDES IN DIAMOND GRINDING. Samsonov, G. V.; Bozhko, S. A.; Kushtalova, I. P. (Inst. of Problems in Material Handling, Kiev). Dokl. Akad. Nauk SSSR; 198: No. 1, 83-5(1 May 1971). (In Russian).

The plastic deformation of TiC, ZrC, and NbC (or rather the substoichiometric versions of these) in the course of diamond grinding is considered in relation to the crystal structure of the carbides and the stable electron configurations of the atoms composing them. The diamond grinding of these materials leads to surface hardening, the fine structure of the hardened layer being characterized by a reduced block size but few distortions. The ductility increases in the order TiC, ZrC, NbC, in agreement with the corresponding fall in the degree of stabilization of the sp^3 configurations of the C atoms. (Metals Abstr.)

18167 STUDY OF PHASE TRANSFORMATIONS IN CHEMICALLY DEPOSITED BORON–NICKEL COATINGS. Petrov, Yu. N.; Kovalev, V. V.; Markus, M. M. (Inst. of Applied Physics, Kishinev, USSR). Dokl. Akad. Nauk SSSR; 198: No. 1, 118-21 (1 May 1971). (In Russian).

Phase transformations taking place in chemically deposited Ni–B coatings were studied by thermal analysis, measurements of microhardness, and x-ray diffraction. Thus the diffraction lines of Ni, Ni_2B, and another phase of hexagonal symmetry were identified, the proportions of these depending on the nature of the additives incorporated in the original solutions. After heat treat-

ment, other phases such as Ni_3B and Ni_7B_3 also developed, together with a certain amount of NiO. (Metals Abstr.)

18168 AXIAL THERMAL EXPANSION OF SOLID SOLUTIONS IN THE ZrO_2–HfO_2 SYSTEM. Gavrish, A. M.; Sukharevskii, B. Ya.; Zoz, E. I.; Solov'eva, A. E. (Physical-Technical Inst. of Low Temperature, Kharkov). Dokl. Akad. Nauk SSSR; 199: No. 4, 880-2(1 Aug 1971). (In Russian).

X-ray dilatometry of solid solutions of the ZrO_2–HfO_2 system was conducted so as to obtain the axial thermal expansion of the monoclinic phase, and the volumetric thermal expansion of both the monoclinic and tetragonal phases. These expansion coefficients were investigated as functions of the mole fraction of HfO_2 in the solid solution. (K.S.W.)

18169 PRODUCTION OF PURE ZIRCONIUM ACID SULFATE AND ZIRCONIUM DIOXIDE FROM ZIRCON CONCENTRATE. Sazhina, V. A.; Kolenkova, M. A.; Motina, A. G.; Prasolov, O. F.; Fam Huong Han (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 72-6(1971). (In Russian).

The possibility of obtaining pure zirconium acid sulfate directly from sulfate solutions from the H_2SO_4 leaching of Zr-lime cake was investigated. The results showed that the presence of impurities in solution does not reduce the recovery of Zr in the zirconium acid sulfate. During leaching Ti removal is accomplished fairly well, but Fe removal is only partial. Extraction experiments for removing Fe and Ti from zirconium acid sulfate are described; but the use of HCl in the lixiviation of the zirconium acid sulfate eliminates the tendency of the Fe to coprecipitate isomorphously with the zirconium acid sulfate. (K.S.W.)

18170 DESSEL PLUTONIUM FUELS PLANT. Leduc, J.; Van Dievoet, J. Nucl. Eng. Int.; 17: No. 189, 93-4(Feb 1972).

The new plutonium plant being built at Dessel in Belgium by Belgonucleaire is due to be operational at the beginning of 1973. Designed for mixed uranium–plutonium oxide fuels it will have an initial throughput for LWR fuel of 30 te/y expandable to 60 te/y in the same building. An outline is given of the general layout, safety features, control of safeguards and of quality. (UK)

18171 ELECTROLESS NICKEL–BORON PLATING BATH; EFFECTS OF VARIABLES ON DEPOSIT PROPERTIES. Mallory, G. O. Plating; 58: No. 4, 319-27(Apr 1971).

Electroless Ni plating solutions using dimethylamine borane as the reducing agent are characterized by the unusual properties of the deposits. Nickel–boron alloys up to 99.9% Ni are obtained with proper control of a given set of plating-bath conditions. The pure deposits have relatively low resistivity, 6 to 15 $\mu\Omega$-cm. The composition of the alloy remains constant over long periods of solution operation. The hardness of Ni–B alloys deposited from solutions operated in the acid pH range lies in the range of 700 to 800 VHN for the as-plated deposit. The influence of variation of solution conditions on deposition rate and the properties of the deposit are reported and discussed. (Metals Abstr.)

18172 DIFFUSION COEFFICIENTS OF OXYGEN IN METAL OXIDES BY AN EMF METHOD. Elyutin, V. P.; Lenskaya, T. G.; Pavlov, Yu. A.; Polyakov, V. P. (Inst. of Steel and Alloys, Moscow). Dokl. Akad. Nauk SSSR; 199: No. 1, 62-5(1 Jul 1971). (In Russian).

The ionic conductivities of TiO_2, Nb_2O_5, Ta_2O_5, and MoO_3 were studied, and the effects of adding other oxides were investigated. A galvanic cell was constructed with Pt + $O_2(p_1,p_2)$ comprising the two electrodes and with a solid electrolyte composed of the oxide under study, which provided emf values. The coefficients of oxygen self-diffusion in the metal oxides were computed by the Nernst–Einstein formula from the relation between the ionic conductivity and the temperature. (K.S.W.)

18173 TOTAL PRESSURE OF URANIUM-BEARING SPECIES OVER MOLTEN URANIA. Reedy, G. T.; Chasanov, M. G. (Argonne National Lab., Ill.). J. Nucl. Mater.; 42: No. 3, 341-4(Mar 1972).

The results of measurements on the total pressures of uranium-bearing species vaporizing from urania at temperatures from the solid region to above the melting point are reported. The measurements were made by determining the vapor density of uranium-bearing species transported in an inert carrier gas according to conventional transpiration techniques. Experiments were performed at 2615, 2860, 3175, and 3390°K. Data are tabulated. (P.C.H.)

18174 THERMAL ETCHING FIGURES IN CERAMIC BODIES. Colombo, R. L. (Centro Sperimentale Metallurgico, Rome); Amato, I. J. Nucl. Mater.; 42: No. 3, 345-7(Mar 1972).

Etch-figures of unusual morphology and whose occurrence is a very rare event, which were found on aluminum oxide and uranium dioxide, are described. The microscopic aspect of the pits simply reflects the fact that each layer can be transformed into its neighbor by a translation and a rotation of 60°. Reasons for the rarity of the phenomenon are explained. (P.C.H.)

18175 COMMENTS ON "CONSIDERATIONS ON PyC AND SiC COATED OXIDE PARTICLES FOR GAS COOLED FAST REACTOR APPLICATION" BY M. DALLE DONNE AND G. SCHUMACHER. Price, R. J.; Gulden, T. D.; Kaae, J. L. (Gulf General Atomic Co., San Diego, Calif.). J. Nucl. Mater.; 42: No. 3, 339-40(Mar 1972).

Discussion is given on a previously published paper which was included in NSA as 25: 42963 in which preliminary data of the authors were used in establishing a limiting creep strain rate for the silicon carbide layer in coated fuel particles. It is stated that there is no experimental basis for establishing a limiting strain as a failure criterion for the silicon carbide layer in coated fuel particles. Also, the assumption of a temperature independent creep rate up to 1400°C is not supported by recent experiments. (P.C.H.)

18176 CONCENTRATE ON TOOLING: IT PAYS. Zlatin, Norman. Mod. Mach. Shop; 44: No. 4, 58-67(Sep 1971).

Use of the optimum grade of carbide in cutting tools increases cutting speed and tool life, particularly with the more difficult-to-machine metals. Carbide grade recommendations for tool steels, cast iron, stainless steel, maraging steel, and alloys based on Ti, Ni, Co, Al, Mg, Cu, W, Mo, Nb, or Ta are listed. Charts illustrate the economic advantages of throwaway inserts. Coated carbide tools are a means of combining a tough substrate with a wear-resistant coating and are recommended to resist crater wear and provide shock resistance. A new micrograin-tool material based on WC has very high transverse rupture strength. It can be used for superalloys, as cutoff tools and in form tools. (Metals Abstr.)

18177 EFFECT OF STOICHIOMETRY ON DIFFUSION OF XENON IN UO_2. Miekeley, W.; Felix, F. W. (Hahn-Meitner Inst., Berlin). J. Nucl. Mater.; 42: No. 3, 297-306(Mar 1972).

The release of fission xenon from UO_2 in the composition range between $UO_{1.934}$ and $UO_{2.250}$ has been studied during post-irradiation diffusion anneal experiments. The results are as follows: UO_{2-y}: $D_0 = 4 \times 10^2$ to 1.6×10^3 cm$^2 \cdot$ s^{-1}; $\Delta H = (6.0 \pm 0.1)$ eV for $1400 \leq T \leq 2200$°C. No correlation was found between D and O/U. $UO_{2.000}$: $D_0 = 5 \times 10^{-2}$ to 5 cm$^2 \cdot$ s^{-1}; $\Delta H = (3.9 \pm 0.4)$ eV for $950 \leq T \leq 1700$°C. UO_{2+x}: $D_0 = 1 \times 10^{-8}$ to 1×10^{-4} cm$^2 \cdot$ s^{-1}; $\Delta H = (1.7 \pm 0.4)$ eV for $600 \leq T \leq 1300$°C. No correlation was found between D and O/U. Under an oxidizing atmosphere the gas release was characterized by an increase in the apparent D during an initial period, t_i, which was found to be influenced by particle diameter and annealing temperature, but not by the initially existing O/U ratio of the sample. Variations of the oxygen partial pressure in the course of several experiments were used to study this effect. The explanation which best fits the experimental observations is that the influence of the O/U ratio on xenon diffusion occurs through an alteration of the trapping probability. The nature of the traps appears to be that of larger vacancy agglomerates. (auth)

18178 ELECTRON MICROSCOPE OBSERVATION OF EPITAXIAL UO_2 FILMS. Nasu, S.; Shiozawa, K.; Kikuchi, T. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 42: No. 3, 307-16(Mar 1972).

Epitaxial fcc UO_2 films were obtained on (100) vacuum cleavage faces of NaCl, KCl, KBr, NaF, and LiF, and a transmission electron microscope observation was made. Films of (100) orientations having extra spots due to micro-twins were most frequently observed for substrate temperatures of 350 to 550°C for NaCl, 350 to 450°C for KCl, 300 to 400°C for KBr, and 500 to 550°C for LiF. Films prepared on NaF in the temperature range from 350 to 550°C were observed to have a perfect (100) orientation without extra spots, while those prepared on LiF at 500°C were sometimes observed to have overlapping (100) and (211) orientations. Registration of fission fragment tracks as straight lines about 100 to 200 Å wide, of bright contrast was observed in films irradiated with thermal neutrons. (auth)

18179 CREEP BEHAVIOR OF CERAMIC NUCLEAR FUELS UNDER NEUTRON IRRADIATION. Brucklacher, D.; Dienst, W. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 42: No. 3, 285-96(Mar 1972).

A theoretical estimation of the irradiation-induced creep rate of UO_2 resulted in a creep rate range between about 6×10^{-6}/h and 8×10^{-5}/h for a fission rate of 1×10^{14} f/cm$^3 \cdot$ s and a stress of 2 kgf/mm^2. It is essentially due to the "thermal rods" along the fission fragment tracks. Therefore, creep rates should only weakly depend on temperature (below 1000 to 1200°C) and must

be markedly lower for carbide and nitride fuel. To prove this estimate by experiments, several types of in-pile creep capsules were developed by which the length or diameter change of pneumatically loaded fuel samples can be measured continuously. In-pile creep experiments on UO_2 were performed at fuel temperatures between 250 and 850°C. The creep rates were proportional to stress (0 to 4 kgf/mm²) and, in a preliminary approximation, also to fission rate (1×10^{13} to 2×10^{14} f/cm³·s) and were in the range estimated before. Within the limits of inaccuracy, the in-pile creep rate was independent of temperature (250 to 850°C). In-pile creep tests on some UN samples resulted in creep rates that are lower by an order of magnitude than for UO_2 under comparable conditions. The porosity dependence of the UN in-pile creep rate was found to agree with an adequate out-of-pile relationship for ceramic materials. (auth)

Metals and Alloys

Refer also to abstract 17467.

18180 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Dezember 1971. Band 5, Heft 12. 180 Referate (Register-Nr.4593-4891), 79 Referate (Register-Nr.630T-708T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. December 1971. Vol. 5, No. 12. 180 Abstracts (Register No. 4593-4891), 79 Abstracts (Register No. 630T-542T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1971). 115p. (In German and English).

Corrosion and Erosion

Refer also to abstract 18152.

18181 (AE-437) STUDIES OF THE TENDENCY OF INTERGRANULAR CORROSION CRACKING OF AUSTENITIC Fe-Cr-Ni ALLOYS IN HIGH PURITY WATER AT 300°C. Huebner, W.; Johansson, B.; de Pourbaix, M. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Oct 1971. 26p. Dep. NTIS (U. S. Sales Only).

Tests were carried out in high purity water at 300°C with axially stressed specimens of some commercial Fe-Cr-Ni alloys containing 10 to 75% Ni. Both sensitized and nonsensitized materials were studied, the specimens being either plain or precracked, intergranularly or transgranularly. In addition, some specimens were electrochemically etched intergranularly in localized areas. The nominal stress was varied in the range 1 to 3 times $\sigma_{0.2}$ at 300°C. Tests were also performed with specimens stressed in a more complex way, such as U-bends. Chloride contents of less than 1 ppM and oxygen contents ranging between 0.005 and 400 ppM were studied in tests up to 1700 h. Electrochemically accelerated tests were performed with potentiostatically controlled specimens. Polarization curves were measured at temperatures up to 300°C. With uniaxially stressed specimens cracking was only found on sensitized Types 302 and 304 stainless steel, whereas U-bend tests resulted in cracking also of alloy 600 and Inconel-X 750 after less than 1500 h. No cracking was found in alloy 800. The electrochemical tests showed intergranular cracking within 72 h at high values of anodic polarization on both alloy 600 and sensitized Type 304 stainless steel. Cathodic polarization also resulted in various types of localized attack. The results of the stress corrosion tests were compared with other results from high purity water tests found in the literature. (auth)

18182 (WARD-4210-T-1-3) SODIUM TECHNOLOGY PROGRAM. Progress Report for the Period Ending August 31, 1971. Ray, W. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.). Contract AT(30-1)-4210. 83p. Dep. NTIS.

Activities in programs to measure wear rates and friction coefficients of several materials for use in Na environments in FFTF are reported. Other research is described on development of meters for use in determining O in Na. (J.R.D.)

18183 (WCAP-7776) EFFECT OF AN ENVIRONMENT OF HIGH TEMPERATURE PRIMARY GRADE NUCLEAR REACTOR WATER ON THE FATIGUE CRACK GROWTH CHARACTERISTICS OF A533 GRADE B CLASS 1 PLATE AND WELDMENT MATERIAL. Mager, T. R.; McLoughlin, V. J. (Westinghouse Electric Corp., Pittsburgh, Pa.). Oct 1971. Subcontract 3290. 47p. (HSSTP-TR-16). Dep. NTIS.

For Oak Ridge National Lab., Tenn.

Using the fracture mechanics approach, the effects of an environment of high temperature primary grade reactor water on the fatigue crack growth characteristics of nuclear pressure vessel grade materials were evaluated. Environments (excluding irradiation) typical of both Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR) were studied. Materials investigated included A533 grade B, class 1 steel (HSST Plate 02), and weldments produced by the submerged-arc process, the manual-arc process, and the electroslag process. Included in the experimental program were: an evaluation of the influence of frequency, 60 to 600 cycles per minute; the influence of oxygen and hydrogen on the fatigue crack growth rate; and determination of cyclic crack growth rate properties of A533 grade B class 1 material in air for comparison. The results indicated that an environment of primary grade reactor water does not increase the cyclic crack growth rate of A533 grade B class 1 plate and weldment material. Data are presented in terms of da/dN versus ΔK for each variable investigated. It was concluded that the crack growth rate data for the base plate material at 75°F encompasses all other data except data generated in a hydrogen environment. (auth)

18184 CORROSION BEHAVIOUR OF NICKEL-PLATED URANIUM. Orman, S.; Owen, L. W.; Picton, G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Corros. Sci.; 12: No. 1, 35-44(Jan 1972).

The corrosion behavior of uranium metal electroplated with nickel was investigated. The protective quality of the plating decreases after prolonged exposure to aqueous environments due to loss of adhesion. The disrupting entity is uranium hydride formed at the nickel-uranium interface. The electrodeposited nickel film was found to be permeable to hydrogen. No nickel films removed from uranium were found to be free of pores although similar films removed from stainless steel were. A mechanism for the corrosion of uranium beneath the nickel plating is proposed. (auth)

18185 STUDY OF A HIGHLY CORROSION RESISTANT CAST NICKEL-CHROMIUM-MOLYBDENUM ALLOY. Lev, V. Z.; Klinov, I. Ya.; Yakhnina, V. D.; Shapiro, M. B.; Frolov, N. A. Khim. Neft. Mashinostr.; No. 1, 26-8(1971). (In Russian).

Results are given from a study of Ni-Cr-Mo alloys containing various amounts of Si. The composition ranges in which these alloys tend to undergo intercrystalline corrosion were determined and their casting properties established. The optimum alloy composition was determined and recommendations made for the heat treatment regime. (Referativnyi Zh.)

18186 INVESTIGATION OF THE STRUCTURE AND CORROSION BEHAVIOR OF ALLOYS OF THE SYSTEM Ti-Ta-Cr. Tomashov, N. D.; Chernova, G. P.; Kalnina, G. S.; Budberg, P. B.; Gavze, A. L. (Inst. of Physical Chemistry, Moscow). Zashch. Metal.; 7: No. 4, 387-91(Jul-Aug 1971). (In Russian).

The structure and corrosion behavior of alloys of the system Ti-Ta-Cr, containing Cr from 2.5 to 20% and Ta up to 30%, were investigated, using for the analysis of the phase equilibrium the microstructure, roentgenophase, differential-thermal, and dilatometry methods and characteristic diagrams of the alloys subjected to hot plastic deformations in the temperature interval of 1,000 to 600° and subsequent hardening (1,200 to 600°). Depending on the temperature of heat treatment, these alloys can have a homogeneous structure of a β-solid solution or a heterogeneous structure $\alpha + \beta + \gamma$. The results are discussed by reference to the microstructure and diagrams of polythermal cuts of the alloys by different correlation of their components and effects of the alloying components on the corrosion rate. It was found that the stability region of the β-phase on the state diagram increased and the beginning eutectoid transformation $\beta \rightarrow \alpha + \gamma$ shifted into the region of higher contents of alloying elements and lower temperatures by increasing the relative content of Ta to Cr relations of 1:3, 1:1, and 3:1. The corrosion rate of alloys with homogeneous structure was lower than that of alloys with heterogeneous structure by 2 to 10 times and more. The Ti-Ta-Cr alloys with Ta: Cr = 3:1 and the Ti-Ta alloys with a Ta content of 20% and higher were corrosion-resistant in 5% HCl at 100°. The Cr alloying of Ti decreased its corrosion properties in the HCl-solution and the corrosion rate increased with increasing Cr content, particularly for alloys with heterogeneous structure. (JPRS)

18187 EFFECT OF NEUTRON IRRADIATION ON THE STRESS CORROSION PROPERTIES OF 7075 ALUMINUM. Jacobs, A. J.; Bentle, G. G. Corrosion; 26: No. 5, 201-13(May 1970).

An investigation was conducted to determine the effects of irradiation on the stress corrosion susceptibility of 7075 aluminum. Specimens of 7075 in three heat treated conditions (-T6, -T73, and a condition intermediate to these) were irradiated with fast neutrons. The -T6 alone of the three tempers underwent a significant loss in stress corrosion resistance at fluences $\geq 10^{19}$ nvt. The only corresponding change in mechanical properties was a decrease in

reduction of area. Continuous ultrasonic monitoring of unirradiated and irradiated stress corrosion specimens indicated that crack initiation consumes ~90% of the total time to failure. (auth)

18188 BEHAVIOR OF TITANIUM AND ITS ALLOYS WITH TANTALUM DURING CATHODIC POLARIZATION IN NITRIC ACID SOLUTIONS. Karasev, A. F.; Stabrovskii, A. I. Zashch. Metal.; 6: No. 3, 324-6(May-Jun 1970). (In Russian).

The electrochemical behavior of Ti, Nb, and Ta, and the corrosion resistance of Ti and Ti–Ta alloys in HNO_3 solutions (2 to 8 M) were investigated over the temperature range 20 to 80°C. The corrosion rates were reported for Ti alloys containing 8%, 10%, and 15% by weight of Ta. (K.S.W.)

18189 HEAT RESISTANCE OF TITANIUM ALLOY ST-4 AND EFFECT OF PROTECTIVE COATINGS ON IT. Kornilova, Z. L.; Ignatov, D. V.; Lazarev, E. M. Fiz. Khim. Obrab. Mater.; No. 3, 113-16(May-Jun 1971). (In Russian).

The heat resistance of a Ti–Al–Zr–Sn–Fe alloy (ST-4) and certain Mo–Si and Ti–Si coatings commonly used to protect it was studied. The best protective properties against gas corrosion at 800 to 1000°C were afforded by coatings of the Ti_5Si_3 type. The heat resistance of the ST-4 alloy with a coating of this compound at 800°C was greater than that of a heat-resistant Ni–20% Cr alloy. By using the coatings in question the harmful effects of O and N dissolution in the alloy were largely averted. (Metals Abstr.)

18190 BEHAVIOR OF PROTECTIVE METALLIC COATINGS IN FRESH WATER. Pavlova, F. S.; Gerasimov, V. V.; Ermolova, T. A. Zashch. Metal.; 6: No. 5, 622-5(Sep-Oct 1970). (In Russian).

Samples of polished 0X18H10T carbon steel were coated with 100 μ Ni, 250 μ Cr, or 60 μ Cd (other samples were given a coating of Cu of unspecified thickness). Polarization curves showed that at 20 and 70°C, with the exception of Cd, all metallic coatings possessed a region of passive state in water, but narrower than that for steel. A high corrosion resistance was noted for Cr and for electrolytic Ni and is explained in terms of their steady-state potential in contrast to P-containing Ni and Cd (from the method of deposition). (K.S.W.)

18191 HIGH-TEMPERATURE OXIDATION OF NICKEL AND ITS ALLOYS WITH OXIDES. Pashkova, O. A.; Zhuk, N. P.; Opara, B. K.; Burtseva, N. I. (Moscow Inst. of Steel and Alloys). Zashch. Metal.; 6: No. 5, 591-3(Sep-Oct 1970). (In Russian).

The rate of oxidation of pure Ni at 800 to 1,050°C was investigated with 3 to 5% of the following substances as oxidizing agents: ThO_2, ZrO_2, HfO_2, Al_2O_3, and TiO_2. The oxidation rate of Ni was determined as a function of the reciprocal of the absolute temperature. These log rate vs 1/T curves were characterized by an abrupt discontinuity at 900°C, corresponding to a change in the effective activation energy of oxidation. (K.S.W.)

18192 KINETICS OF DISSOLUTION OF MOLYBDENUM IN 2 N HNO_2 CONTAINING UREA. Putilova, I. N.; Suponitskaya, I. I. (Moscow Technological Inst. of the Food Industry). Zashch. Metal.; 6: No. 5, 571-2(Sep-Oct 1970). (In Russian).

Urea was tested as a possible corrosion inhibitor of sheet Mo in 2 M HNO_3 [temperature of corrosion tests not stated]. The addition of 25 mole of urea/liter not only lowered the rate of dissolution of Mo but decreased the steady-state potential of the metal, presumably by removal of the catalyst HNO_2. (K.S.W.)

18193 CORROSION RESISTANCE OF VANADIUM ALLOYS IN BOILING ACIDS. Vorob'eva, L. P.; Gulyaev, A. P.; Druzhinina, I. P. (State Scientific-Research and Planning Inst. of the Rare Metals Industry, Moscow). Zashch. Metal.; 6: No. 5, 537-40(Sep-Oct 1970). (In Russian).

The corrosion resistance of samples of V of various degrees of purity and of samples of V alloys with Ti, Nb, Ta, Mo, and W in concentrations of from 2 to 31 at. % was evaluated. The corrosion environments consisted of boiling solutions of the following acids in a variety of concentrations: HCl, H_2SO_4, H_3PO_4, and HNO_3. Although V lacked corrosion resistance, and alloying with Ti increased its corrosion rate, alloying with Nb, Ta, Mo, or W decreased it. (K.S.W.)

18194 DISSOLUTION OF ALLOYS OF THE TYPE $Al_{50}Ni_{50-x}Me_x$ IN ALKALI. Aleikina, S. M.; Marshakov, I. K.; Fasman, A. B.; Vavresyuk, I. V. (Voronezh State Univ., USSR). Zashch. Metal.; 6: No. 6, 691-4(Nov-Dec 1970). (In Russian).

The corrosion behavior of alloys of the composition $Al_{50}Ni_{50-x}Me_x$ was studied in 0.1 N NaOH, where Me = V, Nb, Ta, or Zr in concentrations from 0.0 to 25 wt %. Corrosion proceeded rather slowly and was readily measured by the amount of hydrogen evolved. Anodic polarization curves for these systems were drawn. Attack on these ternary alloys was primarily due to selective dissolution of the β-phase, and the metallic Ni formed possessed the normal crystalline structure. (K.S.W.)

18195 INTERNAL OXIDATION OF Ag–Be ALLOYS. Pravoverov, N. L. Zashch. Metal.; 6: No. 6, 661-6(Nov-Dec 1970). (In Russian).

The lamellar separation observed in structures of oxidized alloys of Ag–Be is frequently associated with temperature fluctuations or oxygen pressure variations. Here the experimental conditions are described for forming similar structures during the oxidation of Ag with additions of 0.20, 0.24, and 0.28 wt % Be. Annealed and work-hardened specimens were oxidized at temperatures from 400 to 800°C, resulting in the development of zones of internal oxidation both in furnaces with fluctuating temperatures and in temperature-stabilized furnaces. Discontinuities in oxidation were attributed to the nature of the alloy, and were obtained under conditions of opposing diffusion currents of oxygen atoms and metal undergoing oxidation. (K.S.W.)

18196 OXIDATION-RESISTANT COATINGS FOR REFRACTORY METALS. Allen, B. C. DMIC Rev.; 3p(21 May 1971).

Reviews are presented on coatings for Nb and Ta alloys and Ni–Cr and Ta hardware is evaluated. Clad-core Nb alloys for turbine blades, VAM-79, SU-31 and Nb-132M were evaluated and Nb-132M was chosen for the core. Nb–15Ti–10Ta–10W–2Hf–3Al and Nb–5W–30Hf–5Ti–3Re alloys were vacuum diffusion-bonded onto the Nb-132M, but the combination had marginal creep strength and microstructural stability. Tests on Hf-based claddings on Nb-752 and Ta–10W, Hf–24.5Ta–1.8Cr–1.1Si, and Hf–24.5Ta–1.2Cr–0.7B–0.12Al showed that oxidation life varied widely. Stabilized Cr_2O_3 coating on Cr-base alloys was developed to protect against embrittlement in air at high temperature and improved oxidation resistance, but the protection was not considered adequate for jet service. (Metals Abstr.)

18197 CORROSION RESISTANCE OF TITANIUM AND TITANIUM–5 PERCENT TANTALUM ALLOY IN HOT CONCENTRATED NITRIC ACID. Takamura, A.; Arakawa, K.; Moriguchi, Y. (Kobe Steel Ltd., Japan). pp 209-16 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The corrosion behavior of titanium in hot concentrated nitric acid was investigated and the effects of alloying elements on the corrosion resistance of titanium alloys were studied. Although titanium was in the passive state in boiling nitric acid, the corrosion rate under passive state was found to increase with increasing concentration of acid. Corrosion was suppressed in the presence of a very small amount of titanium ion in the acid. Therefore the corrosion rate determined in conventional laboratory tests was found not necessarily to give a meaningful figure because it was strongly affected by the duration of test and volume of test solution. Corrosion rate of titanium on which 68% nitric acid was condensing, was estimated to be as high as 1 mm/year where no titanium ion accumulated. Among the alloying elements, molybdenum, niobium, vanadium, zirconium, aluminium, silicon, manganese, and tantalum, which were investigated in order to improve the corrosion resistance of titanium in nitric acid solution, tantalum was found to be the most effective. Corrosion decreased by increasing the amount of tantalum in the alloy. Also, a more stable passive film was formed on the titanium–tantalum alloy even in the presence of an extremely small amount of dissolved titanium ion. Consideration of corrosion resistance, mechanical properties, fabrication, and cost led to the optimum tantalum addition of 5% for the alloy as the nitric acid resistant material. The mechanical properties and weldability of the alloy was almost the same as the commercially pure titanium. The titanium–5% tantalum alloy is now in use as the material of construction for equipment handling hot concentrated nitric acid solution. (auth)

18198 UTILIZATION OF ANODIC BREAKDOWN OF TITANIUM ALLOYS AS A METHOD OF CHARACTERIZATION. Murphy, T. J. (Titanium Metals Corp. of America, New York). pp 217-23 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference- London, England (21 May 1968).

The significance of anodic breakdown phenomena as a function of Ti surface condition is emphasized. A device for measuring anodic breakdown characteristics is illustrated. The principle of the method is that when specimen potential is raised to the breakdown potential, a pit initiates; if current flow at the pit is a large proportion of the total applied current, the potential will fall to a value at which pitting may no longer continue. Since the size of a pit so initiated is independent of the total area of a specimen, it

is important that the exposed area should be as small as possible. Results are given for tests on Ti–Al base alloys with varying amounts of Mo and/or V. The significance of the results are discussed. (P.C.H.)

18199 ELECTROCHEMICAL MECHANISM IN THE STRESS CORROSION CRACKING OF TITANIUM ALLOYS. Beck, T. R. (Boeing Scientific Research Labs., Seattle). pp 239–45 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

A pictorial presentation is given for the currently envisaged electrochemical events in a propagating stress corrosion crack (SCC) in titanium based on SCC experiments, electrochemical kinetics data on newly generated metal surface, and quantitative mass-transport-kinetics model formulation. A halide ion interaction at the tip of the crack is indicated as involved in the SCC mechanism. Some approximate limiting cases from the more general mass-transport-kinetic formulation are presented and compared to experimental SCC data. (auth)

18200 SOME CHARACTERISTICS OF AQUEOUS STRESS CORROSION IN TITANIUM ALLOYS (SUMMARY). Fager, D. N.; Spurr, W. F. (Boeing Co., Seattle). pp 259–61 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The influence of microstructural features on the stress corrosion fracture path was studied in the high-α alloys Ti–8Al–1Mo–1V, Ti–6Al–4V, Ti–4Al–3Mo–1V, and Ti–5Al–2.5Sn and in the β alloy Ti–13V–11Cr–3Al by means of optical microscopy, electron microscopy, and x-ray diffraction. Stress corrosion cracks occurred in the α-phase but not in the β or martensite phases in the high-α alloys containing Mo and V. In these alloys, stress corrosion susceptibility decreased as the amount of the β or martensite phases increased due to variations in alloying or heat treatment. Stress corrosion cracks occurred on or near the 100 planes in the β phase of Ti–13V–11Cr–3Al. Coplanar dislocations were observed in the nonsusceptible Ti–8Al–1Mo–1V martensite indicating that although they may be necessary for stress corrosion they do not control susceptibility differences. A composition-influenced surface feature, rather than a structural feature is suggested as the controlling factor for the susceptibility of individual phases. (P.C.H.)

18201 AMBIENT TEMPERATURE STRESS CORROSION CRACKING IN Ti–8Al–1Mo–1V. Shaffer, I. S. (Naval Air Development Center, Warminster, Pa.); Lawley, A. pp 263–5 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies were made on the possible correlation between dislocation substructure and ambient temperature stress corrosion susceptibility in Ti–8Al–1Mo–1V. Stress corrosion tests revealed that the heat treatments conducted did not produce immunity to stress corrosion cracking. Cantilever specimens of all heat treatments displayed severe susceptibility to cracking at reduced stress levels in the salt water environment. Heat treating, however, did improve fracture toughness of the material as measured by specimens continuously loaded to failure in air. Also, the heat treatments at 1450 and 1800°F gave an increase in the threshold value of stress intensity needed to promote stress corrosion cracking. Metallographic examination of partially failed specimens showed stress corrosion cracking did not follow any preferred path. The crack tended to cross alpha grains or to follow grain boundaries more or less at random, suggestion that stress concentration was controlling the crack direction. (P.C.H.)

18202 STRESS CORROSION CRACKING IN TITANIUM AND TITANIUM ALLOYS. Jackson, J. D.; Boyd, W. K. (Battelle Memorial Inst., Columbus, Ohio). pp 267–81 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, Engand (21 May 1968).

The present general position on the stress corrosion cracking of Ti is presented by first reviewing some of the general features associated with some of these aggressive environments that have not been studied in much detail. This is followed by a discussion in some detail of the metallurgical and environmental factors which appear to play a role in the cracking mechanism, particularly as associated with the exposure of Ti and its alloys to hot salt, nitrogen tetroxide, methanol, and seawater. The results showed that while the addition of alloying elements can alter corrosion behavior by affecting the polarization of anodic and/or cathodic reactions, it does not seem that alloy content significantly affects the corrosion reactions of Ti alloys. Rather, it appears that the compositional dependence of stress corrosion cracking behavior of Ti alloys is related to the distribution of sites for localized attack or to the absorption and precipitation of embrittling or highly anodic species. With the exception of N_2O_4, the mechanism of cracking appears to involve at least in part an electrochemical step. The data suggest that critical levels exist for both oxygen and water at which cracking times are at a minimum. The presence of an active chloride species also seems to increase susceptibility to cracking in all environments. There is strong evidence to suggest that a part of the cracking mechanism involves absorption of embrittling species from the environment. (P.C.H.)

18203 EFFECTS OF HALOGEN-CONTAINING HYDROCARBONS UPON STRESSED Ti–6Al–4V ALLOY. Kamber, K.; Kendall, E. G.; Raymond, L. (Aerospace Corp. Labs., El Segundo, Calif.). pp 293–8 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The postulated mechanism that sufficiently free Cl_2 exists in Freon TF to produce stress corrosion cracking failure in Ti–6Al–4V was invalidated. Neither weld areas nor degraded oxide surface layers were adequate to negate this conclusion. To substantiate the test method, previous results demonstrating stress-corrosion cracking in a Freon MF environment were confirmed. Only by doping Freon TF with large quantities of Cl_2 could stress corrosion cracking of Ti–6Al–4V be observed. This observation was contingent on maintaining the high Cl_2 concentration throughout the duration of the test. If chemical equilibrium of the Cl_2 in Freon TF was achieved before the critical flaw size was attained, flaw growth terminated and further substantiated the inadequacy of the equilibrium Cl_2 concentration in Freon MF as a cause of stress corrosion cracking of Ti–6Al–4V. (auth)

18204 CRACKING OF TITANIUM ALLOYS UNDER STRESS DURING OXIDATION IN AIR. Zwicker, U.; Kalsch, E. (Univ., Erlangen, Ger.). pp 299–306 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Annealed and recrystallized titanium alloys containing aluminum and vanadium were found to be much more susceptible to crack propagation under stress at 450 to 600°C than cold-worked material. If the material was cold worked there was a formation of many cracks in and just below the oxide layer, but no propagation into the depth of the alloy. The shape of the cracks depends on the composition of the alloys. Crack-propagation in annealed material occurred along α–boundaries and β–α–contacting areas. In the case of surface deformation in cold worked material, there was no possibility of crack-propagation along the grain boundaries, and, therefore, only the surface layer was susceptible to crack formation. Details of the shape of cracks and of the change of alloy concentration in the surface layers of various titanium alloys are discussed. (auth)

18205 TITANIUM ALLOY PRESSURE VESSELS IN THE MANNED SPACE PROGRAM. Johnson, R. E. (Manned Spacecraft Center, Houston, Tex.). pp 1175–86 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The general construction and design of Ti pressure vessels for spacecraft are described, and data on two stress corrosion problems involving Ti alloy pressure vessels are presented. In one problem (Ti–N_2O_4), a small change in fluid chemistry resulted in a significant change in reactivity, emphasizing the need for careful control of contaminants or minor fluid constituents. In the other problem (Ti–methanol), general lack of knowledge about subtle metal-fluid reactions resulted in significant loss of hardware. However, the use of Ti alloys in the U. S. manned space program for basic structure and pressure vessels has been, for the most part, successful. (P.C.H.)

18206 RADIOCHEMICAL TECHNIQUE FOR DETERMINING DEPTH DISTRIBUTIONS IN Mo. Arora, M. R.; Kelly, Roger (McMaster Univ., Hamilton, Ont.). J. Electrochem. Soc.; 119: No. 2, 270–4(Feb 1972).

Molybdenum can be anodized at up to 235V in an electrolyte

containing glacial acetic acid, $Na_2B_4O_7 \cdot 10\ H_2O$, and water. The resulting oxide films, which must be stabilized by compressed-air drying, show brilliant interference colors, have a linear (or nearly linear) thickness-voltage relation, and can be formed with thicknesses of up to 380 $\mu g/cm^2$ of oxide (~ 8400Å). When exposed to 1.0 g/liter aqueous KOH, the films dissolve (strip) within 30 sec, whereas the underlying metal dissolves at a rate of only 20 Å/h. The film thicknesses formed on Mo which has been subjected to Kr ion bombardment at doses of up to 4×10^{16} ions/cm^2 are similar to those on unbombarded specimens. It follows from these results that the use of an anodizing-stripping sequence for determining depth distributions in Mo should be possible. Examples of depth distributions for 10-keV Kr implanted at doses from 4×10^{13} to 4×10^{16} ions/cm^2 are given and are shown, by comparison both with theory and with previously obtained results for W, to be numerically plausible. (auth)

18207 MECHANISM UNDERLYING THE EFFECT OF AMINOCHROMATES AS INHIBITORS OF METAL CORROSION. Ivanov, E. S. Zashch. Metal.; 7: No. 2, 193-4(Mar-Apr 1971). (In Russian).

The mechanism responsible for the observed corrosion-inhibiting properties of aminochromates is discussed on the basis of published data, together with fresh tests on C steel, Al, Zn, Cu, and Cd. The protection of these metals from corrosion in aminochromates is apparently due to a combination of two factors: the presence of an oxide film on the metal due to the oxidation of its surface by the chromate ions; and the presence of multiple layers of chromate ions adsorbed physically on the metal surface. These results are supported by existing data. (Metals Abstr.)

18208 LIQUID METALS. Cybulskis, P. DMIC Rev.; 5p(4 Aug 1971).

Recent research on liquid metals includes work on: the corrosion of steel, Ni alloys, Nb and other structural materials in Na; flowing loop studies of the behavior of 316 and 304 stainless steels in Na; the resistance of TZM alloy exposed to Na at 1177 and 1071°C; the corrosion of V and V-base alloys in Na at 450 to 700°C; the rate of oxidation of pure Ta in Na_2O-saturated liquid Na; the effects of O content and heat treatment on the compatibility of Li with Nb and Ta alloys; the effects of gettering elements, such as Be, Hf, Sm, Ti, Th, and Zr, on the resistance of 321 stainless steel to molten alkali metal; the apparent solubilities of pure Ta and Nb in liquid K; mechanisms of refractory metal penetration by alkali metals and corrosion mechanisms for V–Ti and V–Al alloys in Na. (Metals Abstr.)

18209 KINETICS OF THE OXIDATION OF NIOBIUM IN THE PLASMA OF A HIGH-FREQUENCY DISCHARGE. Makara, E. V.; Mikhalkin, V. S.; Odynets, L. L. Elektrokhimiya; 7: No. 8, 1096-9(Aug 1971). (In Russian).

The oxidation of a Nb surface subject to anodic polarization in the O plasma of an hf electrical discharge was studied. On oxidation in the galvanostatic mode the thickness of the oxide layer varied logarithmically with the period of oxidation; the thickness also varied linearly with the applied voltage. The V/A relationship of the oxide layer was of the same nature as that generally obtained in the electrochemical oxidation of Nb. The general laws governing the oxidation of the Nb surface in the hf discharge and in aqueous electrolytes were very similar to one another. (Metals Abstr.)

18210 EFFECT OF CHLORIDE IONS ON THE CRACKING BEHAVIOR OF U/7.5 WT. PERCENT Nb/2.5 WT. PERCENT Zr AND U/4.5 WT. PERCENT Nb. Magnani, N. J. (Sandia Labs., Albuquerque, N. Mex.). J. Nucl. Mater.; 42: No. 3, 271-7(Mar 1972).

The effects of chloride ions on the stress corrosion cracking behavior of U–7.5 wt% Nb–2.5 wt% Zr and U–4.5 wt% Nb have been investigated utilizing a fracture mechanics approach to study the rate of crack propagation. The tests showed that chloride ion concentration strongly affects both the crack velocity and the fracture mode. The threshold stress intensities for stress corrosion crack propagation for both alloys have been determined in aqueous solutions containing <2 ppM and 50 ppM Cl^-. The threshold stress intensity for the U–7.5 wt% Nb–2.5 wt% Zr alloy in the <2 ppM Cl^- solution was 15 ksi·$in^{½}$ while in the 50 ppM Cl^- solution it was less than 5 ksi·$in^{½}$. The binary alloy has essentially the same stress intensity threshold in both solutions, 14 to 17 ksi·$in^{½}$. At the highest chloride levels tested (500 ppM) stress corrosion cracking was observed without the application of stress. This was attributed to corrosion product wedging. (auth)

Preparation and Fabrication

Refer also to abstracts 19636 and 19639–19641.

18211 (RDT-M-1-1-T(7-71)) STAINLESS STEEL COVERED WELDING ELECTRODES (ASME SFA-5.4 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for stainless steel covered welding electrodes (ASME SFA-5.4 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 1-1T, dated February 1969. (J.R.D.)

18212 (RDT-M-1-6-T(7-71)) MILD STEEL ELECTRODES AND WELDING RODS (ASME SFA-5.18 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for mild steel electrodes and welding rods (ASME SFA-5.18 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 1-6T, dated February 1969. (J.R.D.)

18213 (RDT-M-1-20-T(1-72)) MILD STEEL ELECTRODES FOR FLUX-CORED ARC WELDING (ASME SFA-5.20 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 8p. RSO.

A standard prescribing requirements for mild steel electrodes for flux-cored arc welding (ASME SFA-5.20 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

18214 (RDT-M-2-3-T(7-71)) CARBON AND ALLOY STEEL WELDING FITTINGS (ASME SA-234 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 10p. RSO.

A standard prescribing requirements for carbon and alloy steel welding fittings (ASME SA-234 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 2-3T, dated February 1969. (J.R.D.)

18215 (RDT-M-2-6-T(7-71)) MARTENSITIC STAINLESS STEEL (TYPE 403) FORGINGS (ASME SA-182 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 10p. RSO.

A standard prescribing requirements for martensitic stainless steel (Type 403) forgings (ASME SA-182 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 2-6T, dated February 1969. (J.R.D.)

18216 (RDT-M-2-9-T(1-72)) ZIRCONIUM AND ZIRCONIUM ALLOY FORGINGS AND EXTRUSIONS (ASTM B356 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 6p. RSO.

A standard prescribing requirements for Zr and Zr alloy forgings and extrusions (ASTM B356 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 2-9T, dated May 1970. (J.R.D.)

18217 (RDT-M-2-15-T(10-71)) NICKEL–CHROMIUM ALLOY BARS, FORGINGS, AND FORGING STOCK (ASTM A637 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1971. 9p. RSO.

A standard prescribing requirements for Al–Cr–Ni bars, forgings, and forging stock (ASTM A637 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 2-15T, dated July 1971 and RDT M 7-2T, dated January 1968. (J.R.D.)

18218 (RDT-M-2-16-T(1-72)) TUNGSTEN FORGINGS (AMS 7897 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 7p. RSO.

A standard prescribing requirements for tungsten forgings (AMS 7897 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

18219 (RDT-M-3-5-T(7-71)) AUSTENITIC STAINLESS STEEL WELDED TUBING (ASME SA-249 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for austenitic stainless steel welded tubing (ASME SA-249 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 3-5T, dated May 1969. (J.R.D.)

18220 (RDT-M-3-6-T(7-71)) AUSTENITIC STAINLESS STEEL PIPE (ASME SA-312 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 7p. RSO.

A standard prescribing requirements for austenitic stainless steel pipe (ASME SA-312 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 3-6T, dated May 1969. (J.R.D.)

18221 (RDT-M-3-7-T(7-71)) AUSTENITIC STAINLESS STEEL WELDED PIPE, LARGE DIAMETER (ASME SA-358 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for austenitic stainless steel welded pipe, large diameter (ASME SA-358 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 3-7T, dated May 1969. (J.R.D.)

18222 (RDT-M-3-9-T(7-71)) NICKEL-IRON-CHROMIUM ALLOY SEAMLESS PIPE AND TUBING (ASME SB-407 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for Ni–Fe–Cr alloy seamless pipe and tubing (ASME SB-407 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

18223 (RDT-M-3-16-T(1-72)) CARBON AND ALLOY STEEL PIPE (ASME SA-333 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 9p. RSO.

A standard prescribing requirements for carbon and alloy steel pipe (ASME SA-333 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

18224 (RDT-M-5-2-T(7-71)) CARBON STEEL PLATES (ASME SA-516 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for carbon steel plates (ASME SA-516 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 5-2T, dated January 1968. (J.R.D.)

18225 (RDT-M-5-4-T(7-71)) NICKEL-CHROMIUM-IRON ALLOY PLATE, SHEET, AND STRIP (ASME SB-168 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 6p. RSO.

A standard prescribing requirements for Ni–Cr–Fe alloy plate, sheet, and strip (ASME SB-168 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT 5-4T dated February 1969. (J.R.D.)

18226 (RDT-M-5-5-T(7-71)) LOW ALLOY STEEL PLATES (ASME SA-387 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 7p. RSO.

A standard prescribing requirements for low alloy steel plates (ASME SA-387 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT 5-5T, dated February 1969. (J.R.D.)

18227 (RDT-M-5-6-T(1-72)) ZIRCONIUM AND ZIRCONIUM ALLOY PLATE, SHEET, AND STRIP (ASTM B352 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 6p. RSO.

A standard prescribing requirements for Zr and Zr alloy plate, sheet, and strip (ASTM B352 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 5-6T, dated May 1970. (J.R.D.)

18228 (RDT-M-5-7-T(7-71)) NICKEL-IRON-CHROMIUM ALLOY PLATE, SHEET, AND STRIP (ASME SB-409 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 6p. RSO.

A standard prescribing requirements for Ni–Fe–Cr alloy plate, sheet, and strip (ASME SB-409 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

18229 (SCL-T-710329) CONTRIBUTION TO THE TECHNOLOGY OF TANTALUM-TUNGSTEN ALLOYS. Braun, H.; Kieffer, R.; Sedlatschek, K. Translated for Sandia Labs., Livermore, Calif., from pp 264-76 of Beitrag zur Technologie der Tantal-Wolfram-Legoerimgem, 1958. 20p. Dep. NTIS.

The available literature on Ta–W alloys is briefly surveyed, and the methods used for the preparation of sintered Ta–W alloys (preliminary formation of solid solutions) and the type of working (cold working, vacuum sheathing, and hot working) are described. The characteristics—density, lattice parameter, hardness, specific electric resistance, hydridability, oxidation resistance, modulus of elasticity, and corrosion resistance—of sintered and cast compositions containing 0 to 100% Ta are presented. (auth)

18230 GROWTH OF TWO-DIMENSIONAL CRYSTALS AND SURFACE MIGRATION IN THE INITIAL STAGES OF VACUUM DEPOSIT FORMATION. Shrednik, V. N.; Odisharia, G. A.; Golubev, O. L. (Ioffe Inst. of Physics and Tech., Leningrad). J. Cryst. Growth; 11: No. 3, 249-54(Dec 1971).

Surface agglomeration of Zr on Nb and W by two-dimensional clusters, the dissolution of these clusters at elevated temperatures, and the outgrowth of W on W caused by one-dimensional diffusion along the atomic rows have been investigated, using the field emission microscope technique. (auth)

18231 PRELIMINARY STUDIES OF THE FABRICATION OF UAl_4–Al TEST-PLATES BY POWDER-METALLURGICAL TECHNIQUES. Jesse, A. (CERN, Geneva); Ondracek, G.; Thuemmler, F. Powder Met.; 14: No. 28, 289-97(1971).

The preparation of UAl_4 by induction melting and annealing at 720°C, yielded a product of restricted UAl_4 content (81 wt %). The UAl_4 phase had a variable stoichiometry ($UAl_{4.0}$–$UAl_{4.8}$), which led to a slightly modified U–Al phase diagram. UAl_4–Al dispersions can be prepared by powder-metallurgical techniques, resulting in structures with higher UAl_4 content, improved phase-distribution rates, and specific particle sizes, compared with melting techniques. The thermal conductivity and thermal expansion of UAl_4–Al dispersions were measured over the whole concentration range. No technological difficulties, by comparison with UAl_3–Al plate fabrication, were encountered. The production of UAl_4–Al test plates (33 vol % $UAl_4 \simeq$ 35 wt % U) is thus feasible on a laboratory scale. This work is the final stage in a series of studies of uranium aluminide–aluminium dispersion fuels obtained by powder routes. (auth)

18232 PREPARATION OF METALLIC URANIUM FILMS FOR NUCLEAR MEASUREMENTS BY UHV EVAPORATION. Mueschenborn, G. Vakuum-Tech.; 20: No. 7, 197-201(Oct 1971). (In German).

High precision targets were prepared by uhv evaporation for measurements of the half life and the neutron fission cross section of the uranium isotopes. Because of the chemical reaction rate of uranium the evaporation was done in a commercially available uhv-bell jar. The first tests with electron guns gave insufficient results because of the low evaporation rate and the high heat dissipation. For this reason a RF levitation melting unit was constructed and set into operation. With a 1 MHz 4 kW oscillator, films of 300 ug/cm^2 are evaporated in about 20 minutes. The evaporated uranium mass was determined by differential weighing in vacuum. (T.F.D.)

18233 SMALL BERYLLIUM-COPPER [2 PERCENT BERYLLIUM] CASTINGS. Antoniotti, E.; Taccardo, C. Fonderia Ital.; 20: No. 1, 35-8(Jan 1971). (In Italian).

The production of small castings weighing 1 to 2 g, of Cu–2% Be for electronic and aeronautical applications is described. The alloy is heated in a 50 kg induction furnace with a SiC pot to 1010 to 1120°C and cast into a solid or monolithic ceramic shell mold in which sprays of as many as 320 castings are attached to the central sprue. The mold is preheated to 320 to 480°C. Differences in cooling rate between the two types of mold give different as-cast microstructures. (Metals Abstr.)

18234 PREPARATION OF VANADIUM BY ELECTROLYSIS OF VCl_3 AND VCl_2 IN FUSED SODIUM AND POTASSIUM CHLORIDES. Ivanovskii, L. F.; Batukhtin, V. P.; Kozlov, F. N.; Plekhanov, A. F. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 27-9(1970). (In Russian).

Laboratory tests on the production of V by the electrolysis of VCl_3 and VCl_2 under Ar in a fused equimolar mixture of NaCl + KCl are reported. The melt contained V 6 wt % (as VCl_2 or VCl_3) with H passed through the melt via the anode which consisted of a graphite tube having a porous end. The anodic and cathodic current density (c.d.) were 0.5 to 1.0 and 1.5 A/cm^2 respectively. The cathode deposit obtained consisted of fine dendrites of V. The current efficiencies using VCl_3 and VCl_2 were 63 to 68 and 70 to 75% respectively. Anodic oxidation of V to VCl_4 did not usually occur and there was no evolution of Cl at the anode potentials reached with an anodic c.d. of 1.5 to 2.0 A/cm^2. (Referativnyi Zh.)

18235 NEW INTERNAL OXIDATION PROCESS FOR STRENGTHENING TUNGSTEN. Blickensderfer, Robert; Copeland, Mark I.; O'Brien, William L. Report of Investigation No. 7521. Washington, D. C.; Bureau of Mines (1971). 40p.

Tungsten alloys with high-temperature strength properties were produced by an oxyreaction process. The process involved additions of a powder of a reactive metal compound, ZrN, ZrW_2, or

HfW_2, to a base metal powder, W, which contained some O. During sintering, diffusion and internal oxidation occurred to produce reactive metal oxide particles and solid solutions. A dispersion of oxide particles could be precipitated by heat treating. Tensile strengthening in the alloys was attributed to Zr in solid solution or to Zr–O–W structures too small to be observed in an electron microscope replica. Stress-rupture life was attributed to a dispersion of submicron ZrO_2 particles which precipitated and grew to 0.05 to 0.2 μm during the test. Tensile strengthening and stress-rupture life were dependent upon both the Zr and O contents with the maximum occurring at roughly 0.9 at. % Zr and 0.9 at. % O. (30 references) (Metals Abstr.)

18236 METAL FINISHING OF NEW METALS AND ALLOYS. Williams, D. R. G. Electroplat. Metal Finish.; 24: No. 2, 32-3; 36(Feb 1971).

Typical properties and problems involved in the fabrication and finishing of high-strength steels, Ti and its alloys, high-strength Al alloys, superplastic metals, and Be are considered. (Metals Abstr.)

18237 EXPANSION OF TUBULAR SPECIMENS OF MOLYBDENUM [CERMET]. Korolev, V. N.; Bukreev, Yu. T.; Galakhov, A. I. Kuznechno-Shtampovochnoe Proizvod.; No. 3, 20-1(Mar 1971). (In Russian).

Experiments were carried out on the expansion of tubular specimens of Mo cermet type MCh using a tapered punch. Dimensions of the specimens were 8, 12, 16, 24, and 30 mm dia, and length 3 × dia. The punch had a taper angle of 15° and the speed of deformation was 0.3 to 0.4 mm/sec. A colloidal graphite lubricant was used (specification GOST 5245-50). Tests were carried out on expanding the specimens 3.7 to 14.3% at temperature 20 to 280°C. Further tests were carried out at a deformation temperature of 250 to 280°C on tubes annealed in H at 800°C for 30 min. The optimum angle of taper of the punch was within the limits 15 to 20°. The speed of deformation should not exceed 0.5 mm/sec and the temperature of deformation must be related to the ductile ⇔ brittle transition temperature. (Metals Abstr.)

18238 URANIUM ALLOY AND ITS MANUFACTURE. Decours, Jacques; Lerouge, Georges (to Commissariat a l'-Energie Atomique). French Patent 2,058,426. 3 May 1971. Filed 2 Sep 1969. (In French).

A Uranium alloy intended for nuclear fuel elements is presented. The alloy has the following composition: 0.5 to 1.5% by weight Mo, 0.03 to 0.15% by weight C and 0.02 to 0.08% by weight of a metal selected from Si, Sn, Cr, and Fe, the remainder being Uranium. (France)

18239 PREPARATION OF RCO_5 PERMANENT MAGNET ALLOYS. Ray, Alden E. (Univ. of Dayton, Ohio); Millott, Harold. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 423-6(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

Procedures for the preparation of alloys suitable for the manufacture of permanent magnets based on $CeCO_5$ and on $PrCO_5$ are described. Single-phase alloys of $CeCO_5$ and $PrCO_5$ are induction-melted, rapidly cooled, and then homogenized. Procedures are also given for preparing low-melting cerium-rich and praseodymium-rich cobalt alloys, which are used as liquid-phase sintering aids in the preparation of the magnets. (auth)

18240 SINTERING OF $PrCo_5$ MAGNETS WITH Pr–Co ALLOY ADDITION. Tsui, James B. Y.; Strnat, Karl J. (Univ. of Dayton, Ohio). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 427-8(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

A systematic study of the sintering conditions for $PrCo_5$ was carried out, using as the liquid-phase sintering aid an alloy that contained 69 wt % Pr and 29 wt % Co. The dependence of the permanent-magnet properties on the grinding time of $PrCo_5$ was evaluated. Different weight ratios of $PrCo_5$ and the Pr–Co additive were tried, and various sintering temperatures and times were studied. It was found that milling time and weight ratio are factors of prime importance for successful sintering. Short milling time and relatively coarse particle size appear to be essential. Magnets sintered under optimum conditions have energy products of nearly 17 MG · Oe, remanence values up to 8500 G, and intrinsic coercive forces up to 9470 Oe. Details of the process and the results are reported. (auth)

18241 INITIAL AND STEADY-STATE POTENTIALS OF ELECTROLYTIC RHENIUM AND OF RHENIUM–NICKEL ALLOYS. Pishikin, A. M.; Popereka, M. Ya. (Kalinin State Pedagogical Inst., USSR). Zashch. Metal.; 6: No. 5, 835-7(Sep-Oct 1970). (In Russian).

The potentials of initial contact with solution and of steady-state electrodeposition of Re and Re–Ni coatings of varying composition were studied under conditions previously described. The steady-state potential of the Re deposit depended on the pH and on the logarithm of the perrhenate concentration. The initial potential was fixed by the mutual decomposition potentials of Re, Ni, and H electrodes in the given solution and by their polarizability. The compositions and phase nature of the Re–Ni deposits are discussed. (K.S.W.)

18242 METALS JOINING. Evans, R. M. DMIC Rev.; 5p (5 Mar 1971).

Fatigue tests are conducted at room temperature to determine the effect of spot welding as a method of attaching strain gages to Ti–6Al–4V alloy. The effect of H environments on tensile properties and crack growth rate of Ti is studied on Ti–6Al–4V specimens with transverse welds. Other studies on Ti materials include hydride banding occurring when a Ti–6Al–4V alloy pressure vessel welded with Ti filler metal failed; the construction of complex structures from Ti alloys by diffusion welding; the effect of brazing time and temperature on the depth of brazing alloy penetration when brazing Ti alloys with Ag and Ag-base brazing alloys. Welding of Al is reviewed, including the factors causing porosity when welding Al and the use of PIGMA welding to reduce porosity. Spot welding of Al to specification is also reported. The effect of stress relieving on strength and toughness of high-strength steel weldments are studied, along with the influence of composition on the toughness of welds in steels used in commercial nuclear reactors. A report on Ni welding covers the results of a standard crack-susceptibility test to characterize postweld heat treat cracking in Rene 41 Ni alloy to find the effects of welding and base metal variables on cracking and to evaluate procedures for desensitizing the heat affected zone by preweld and/or mechanical processing. A technique called activated diffusion bonding is used to form a bond between advanced gas-turbine alloys (Ni-base superalloys, especially Rene 80). (Metals Abstr.)

18243 DEVELOPMENT OF INTERNAL TIG WELDING TECHNIQUE OF SMALL DIAMETER TUBES. Mochizuki, Hirozi; Shimizu, Shigeki; Nakai, Yasuo; Shimizu, Masazo Kawasaki Heavy Industries, Ltd., Kobe, Japan). Kawasaki Giho; No. 39, 42-50(Oct 1970). (In Japanese).

For fabricating steam generators for sodium-cooled fast breeder reactors, it is necessary to weld the tubes to tube-sheet butt joints by inserting a welding torch through the tube-sheet hole of which the inner diameter is very small. Internal TIG welding equipment for tube to tube-sheet butt joints was fabricated and internal welding methods using 2¼ Cr–1Mo steel tubes and 316 stainless steel tubes with inner diameters from 9.5 mm to 28 mm were studied. It was found that internal welding of these tubes is possible by using a newly designed welding torch under the most suitable welding conditions for each tube selected and that the properties of these joints are excellent. (auth) (Japan)

18244 CHOICE OF VACUUM-ARC MELTING PARAMETERS TO ENSURE INGOT CHEMICAL HOMOGENEITY. Dobatkin, V. I.; Anoshkin, N. F. (Inst. of Light Alloys, Moscow). pp 57-65 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Investigations concerned with the methods for production of Ti-alloy ingots in vacuum arc furnaces by consumable electrode remelting are reviewed. On the basis of the investigations, several main conditions for ingot production were established for homogeneous distribution of alloying components. Melting temperature of the alloying components and the master alloy should not exceed the alloy solidus temperature to avoid inclusion formation, but not less than 400 to 500°C to avoid early melting out of the electrode. This condition is carried out by use of the master alloys consisting of the alloy elements including titanium. When it is necessary to introduce a pure high temperature component, the determinating factor is the right choice of the melting parameters and the size of particles that ensures their dissolution in the first melting. During the partial alloying of the consumable electrodes the weight of the charge portions at compacting should not exceed half of the liquid metal weight in the stabilized pool during the first melting. To avoid inhomogeneous distribution of volatile components (Al, Cr, Mn, and others) it is necessary to ensure the optimum pressure of residual or neutral gases. The pressure selection may be carried out on the basis of theoretically sound and experimentally checked correlations. Decrease or full elimination of the inhomogeneity resulting from the zonal liquation is obtained by the choice of the optimum arc current, magnetic field intensity and by carrying out the second re-melting in the direction, opposite to the first one. (auth)

18245 FORGINGS IN TITANIUM ALLOYS. Scanlan, J. V.; Chambers, G. J. G. (High Duty Alloys, Ltd., Redditch, Eng.).

pp 79-95 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The production of forgings in titanium alloys has reached an interesting stage. Up to now there has been little competition from casting, but this situation cannot be expected to continue indefinitely. Intensive development programs will overcome many of the problems associated with the precision forging of titanium alloys and so increase the scope of the forging manufacturer. From the forger's point of view, forging the $\alpha + \beta$ alloys at temperatures above the β transus in cases where the design properties are still adequately satisfied would prove to be a much greater boom. This would enable larger forgings to be made on existing plant and would also help to reduce manufacturing costs in producing conventional forgings. It would further materially assist in the manufacture of close to form or precision type forgings on which costly and wasteful machining could be eliminated. (auth)

18246 HEAVY PRESS FORGING OF LARGE TITANIUM ALLOY PARTS FOR AIRCRAFT AND AEROSPACE APPLICATIONS. Byrer, T. G.; Boulger, F. W. (Battelle Columbus Labs., Ohio). pp 121-31 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Data are given comparing alloys, Ti alloys, and steel, on a strength-to-density basis, and the importance of Ti in future aircraft construction is pointed out. The forgeability of Ti alloys, forged Ti parts, and effects on machine tool requirements are discussed. (P.C.H.)

18247 MONO GRAF CASTING PROCESS. Warnock, R. E. (HOWMET Corp., Whitehall, Mich.). pp 133-41 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The technology of titanium precision casting, as exemplified by the Mono Graf process, is in its infancy in comparison to the titanium wrought product technology. While repair welding is normally required, complex configurations with good mechanical properties and uncontaminated surfaces can be produced. The process has demonstrated that acceptable precision titanium castings are within existing production capabilities. (auth)

18248 HIGH VOLTAGE ELECTRON BEAM WELDING OF TITANIUM ALLOYS IN PARTIAL VACUUM. Bennett, M. G. (Hawker Siddeley Dynamics Ltd., Hatfield, Eng.). pp 1023-36 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The results of the mechanical testing available to data plus the metallographic examinations carried out suggest that the electron-beam welding of titanium alloys, such as Ti-Cu and Ti-6Al-4V, in a partial vacuum system, at a chamber pressure of 10 μ, does not introduce a level of contamination that will impair the properties of these materials. The inherent flexibility of the high-voltage electron beam has been employed to produce a fusion zone geometry in titanium alloys that meets the acceptance standards for welds subjected to fatigue loading. In addition the welds so produced have shown a marked freedom from porosity. The ability to produce acceptable fusion zone profiles through relatively thick sections of titanium alloy, with a 6 kW electron gun, has been demonstrated by varying the mode of beam presentation to the workpiece. The advantage of employing an electron gun of much higher power is obvious from its ability to weld through $1\frac{3}{4}$ in. section at a traverse speed of 50 ipm. (auth)

18249 POROSITY IN ARGON ARC WELDS IN TITANIUM. Taylor, E. A.; Burn, A. H.; Clarkson, H. R. (Imperial Metal Industires Ltd., Birmingham, Eng.). pp 1037-46 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The known effect of many welding parameters on the incidence of porosity in titanium welds can be explained on the basis of the data presented, and it is clear that the most important single variable is concerned with the condition of the sheet edges. Provided sufficient care is taken to eliminate all surface roughness, porosity should not occur in argon arc welds in titanium. However, from a practical aspect, lowest porosity levels are likely to be achieved with reasonable care in edge preparation in conjunction with the highest possible welding speed, the lowest welding current consistent with obtaining satisfactory penetration and adequate argon shielding. (auth)

18250 TITANIUM HOT FORMING. Williams, T. O.; Duerden, J. C. (British Aircraft Corp., Preston, Eng.). pp 1049-51 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The increasing use with decreasing raw material cost of Ti as an aircraft structural material is discussed. The range of Ti sheet discussed includes unalloyed Ti, Cu-Ti, Mo-Ti, Al-V-Ti, Mn-Ti, Al-Mo-V-Ti, and Al-Sn-Ti. Early work with unalloyed sheet Ti, which was limited to rubber press forming and hot forming by hand is described. The use of Ti alloys in the annealed condition eased the production problem and enabled the introduction of the hot platten press technique. The preforming necessary with this process can be difficult and the various methods of producing satisfactory preforms will be discussed. Integrally heated ceramic dies have proved successful for creep forming simple contoured skins where the forming loads can be restricted to 150 psi. The more complex components require special considerations and some of these are discussed. (P.C.H.)

18251 FORMING Ti-6A1-4V SHEET METAL IN FOUR HEAT TREATED CONDITIONS. Chang, J. C. (Rohr Corp., Chula Vista, Calif.). pp 1053-63 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies were made to improve the fabrication of Ti-6Al-4V sheet metal shapes in heat treated conditions. Experience has shown that heat treating titanium parts after forming is impractical due to high rejection rates caused by contamination and distortion. Work was based on the results of a formability analysis of titanium and titanium alloys conducted prior to the fabrication of shapes. The analysis was based on four criteria: mechanical properties of material before and after forming; springback effects; formability limits at temperature; and mechanical properties at forming temperature. As a result of the investigation, it was determined that the most practical procedure of fabricating heat treated parts was to use solution treated and aged (STA) material, preform at 1000°F, then hot-size at 1000 to 1200°F. Two factors were found to be important: Time—time of hot forming and sizing above 1000°F should be kept to 30 min maximum; and Grain direction—grain direction should be controlled to prevent the forming axis from being parallel to the grain or rolling direction. It was demonstrated that Ti-6Al-4V sheet metal parts can be successfully made in STA (165 ksi) and STOA (155 ksi) conditions. The mechanical properties of these parts showed a 15 to 20% increase in tensile and yield strength, a 9.5% increase in notch strength ($K_t = 17$), and a ductility comparable to the mill-annealed parts. (auth)

18252 APPLICATION OF TITANIUM ALLOYS IN THE OLYMPUS 593 ENGINE FOR THE CONCORDE SST. Meleka, A. H. (Rolls-Royce Ltd., Bristol, Eng.). pp 1117-25 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The application of titanium alloys in the Concorde power plant is almost essential to the commercial viability of the aircraft due to substantial weight savings. The majority of components in the LP compressor and a proportion of the HP compressor are made of titanium alloys and the reasons for selection for each application are based on both the mechanical properties of the alloy and its manipulating characteristics. The processes of machining, forging, forming, and welding of titanium and its alloys are now commonplace in the manufacturing procedure of gas turbine aero engines, provided adequate precautions are taken to combat the special characteristics of this class of material. The alloys discussed include Cu-Ti, Al-V-Ti, and Al-Mo-Sn-Ti. (auth)

18253 TITANIUM APPLICATION FOR SUPERSONIC AIRPLANES. Carter, Roger V. (Boeing Co., Seattle). pp 1143-7 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The Boeing supersonic transport will be the worlds first Ti airplane for commercial airline service. It is a Ti airplane in the same sense that current transports are Al airplanes. Ti alloys are the principal structural material in the airframe, accounting for more than 60% of the airframe weight. The

characteristics of Ti alloys leading to their selection for the airframe are: strength-to-weight ratio considerably higher at pertinent temperatures than other candidate materials of suitable toughness; excellent resistance to corrosion and stress corrosion in the SST environment; excellent metallurgical stability in the pertinent temperature range; good fatigue properties; and good raw material availability and fabrication properties. The alloys used for airframe structure include Ti–6Al–4V as the principal one and also Ti–4Al–3Mo–1V and Ti–7Al–4Mo. Raw materials processing, manufacturing processes, and improvements needed are discussed. (P.C.H.)

18254 MATERIAL PROPERTIES DURING THE SOLDERING OF HEAVY METALS. Rubel, Wolfgang. ZIS (Zentralinst. Schweisstech.)-Mitt.; 13: No. 4, 452-61(Apr 1971). (In German).

The effects of material properties on the soldering and brazing processes for cuprous and ferrous metals are reviewed. Materials used for soldering and brazing Cu and Cu alloys are described, e.g., Pb–Sn solders for soldering in the electronics industry. In the case of brazing, the importance of the quality of the Cu is stressed, e.g., electrolytic, O-free or O-containing Cu, and methods to eliminate the detrimental effect of H during brazing are described. The electrical properties of brazing solders are tabulated. The brazing of ferrous metals, including mild steels, high-alloy steels, high-C steels, and grey iron, and sintered carbides (e.g., Co, Ni, W, Ti, Ta, or Mo carbides) is also discussed and the compositions of solders for joining sintered carbides to steel are given. (Metals Abstr.)

18255 IRON–COBALT–CADMIUM DEPOSITION. TERNARY ALLOYS FROM SULFATE BATH. Narang, Shri Krishan; Rama Char, T. L. Metal Finish.; 69: No. 9, 52-3(Sep 1971).

Deposits of 0 to 62% Fe, 0 to 63% Co and 7 to 100% Cd were obtained from a sulfate plating bath containing glycine as a buffer, dextrin and saccharin to improve deposit quality, and ascorbic acid to minimize oxidation of the Fe. Deposits ranged from whitish-grey to mirror-bright, with some stress at higher current densities. Effects of plating variables on deposit composition, cathode efficiency, and cathode potential are tabulated. (Metals Abstr.)

18256 FORMING HEAVY PRESSURE VESSELS. Sudasch, Erich. Weld. Design Fabr.; 44: No. 7, 35-7(Jul 1971).

Thick plate for heavy-wall vessels can be bent cold or hot on presses or rolls. Cold bending is less expensive, produces accurate forms with no scaling or stretching. Hot bending permits much more severe bends in thicker plate. Presses require skilled operators and are not continuous but work closer than rolls. They are used for starting bends on strake plates and for forming strakes with slight tapers or of two plate thicknesses butt welded together. The forming of a heavy-wall reactor vessel in A302 Gr.B steel is described. (Metals Abstr.)

18257 ELECTROLYTIC DEPOSITS OF NIOBIUM OF COMPLEX FORM. Savitskii, E. M.; Mikhailov, B. P.; Baron, V. V. pp 203-8 of Probl. Sverkhprovodyashch. Materialov. Moscow; Izdatel'stvo Nauka (1970). (In Russian).

A method is described for the electrolytic deposition of uniform superconducting Nb coatings onto components of various shapes and dimensions made in non-superconducting materials, e.g., Cu, brass, and Fe. The superconducting properties of the Nb coatings in relation to the electrolysis regimes, and the structure, uniformity, thickness, and purity of the coatings, were studied. Nb coatings of uniform thickness can be produced with a temperature for the transition into the superconducting state of ~ 8.9 to 9.0°K. (Referativnyi Zh.)

18258 CATHODE PROCESSES IN YTTRIUM DEPOSITION FROM HALIDE SALT MELTS. Butorov, V. P.; Nichkov, I. F.; Novikov, E. A.; Raspopin, S. P.; Solin, M. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 85-91(1971). (In Russian).

The Y liberation potentials were measured at a solid Mo and a liquid Zn cathode. Separation of Y onto Mo took place at near-equilibrium potentials, but Y deposition on liquid Zn was accompanied by depolarization potentials of as much as 0.6 V. In the presence of F^- ions Y deposition on liquid Zn exhibited larger negative potentials than in pure chloride electrolytes. Yields of Y in the latter case were 94 to 96%. (K.S.W.)

18259 SELECTION OF HEAT TREATMENT FOR EP454 ALLOY BY MATHEMATICAL PLANNING OF THE EXPERIMENT. Klypin, A. A.; Novik, F. S.; Frolov, Yu. P. (Moscow Aviation Inst.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; 122-7(1971). (In Russian).

A mathematical technique was utilized in planning the optimal heat treatment program for a heat-stable nickel alloy (EP454) consisting of Ni–19% Fe–9.5% Cr–5.8% Mo–5% W–4.3% Al. Parameters determined by the technique were hardening temperature, time interval for hardening, and aging time and temperature. A primary series of experiments were conducted in accordance with the calculated parameters. The results of the primary series were used in a second stage of planning, which in turn culminated in a second series of experiments with narrowed intervals of the variables involved. (K.S.W.)

18260 SCHWEISSEN IN DER KERNTECHNIK. Vortraege des 1. Kolloquiums in Frankfurt/Main am 12. und 13. November 1970. (Welding in Nuclear Technology. First Colloquim Held in Frankfurt am Main, November 12–13, 1970). DVS-Berichte, Band 15. Duesseldorf; Deutscher Verlag fuer Schweisstechnik (DVS) GmbH (1970). 248p. (CONF-701144).

A total of 31 technical papers are presented in which specialized aspects of brazing and welding (including electron beam welding) as used in the construction of nuclear reactors, reactor vessels, and their supporting structures are discussed. Most of the papers deal with austenitic steels, and a few deal with techniques such as x-ray high-speed photography in welding studies and remotely controlled welding equipment. In one paper the mechanical properties of Zircaloy-2 and Zircaloy-4 and their control in semi-finished material production are discussed. (K.S.W.)

18261 FORMING PARTS FROM VAPORS. Blocher, John M. Jr. Mach. Design; 43: No. 16, 58-62(24 Jun 1971).

Vapor-deposition processes can apply coatings at far below their melting points and form intricate configurations with either thick or thin walls. Main applications involve corrosion resistant Al coatings, wear resistant carbide coatings, and free-standing W shapes such as crucibles, caps, cups, and contacts. Wear resistant WC coatings are applied to tools for punching, cutting, and forming metal, while aircraft fasteners are coated with Al for corrosion resistance. Two types of processes are in use, one known as vacuum metallizing, the second as chemical vapor deposition. A table lists a variety of coatings (Re, Ta, Nb, Mo, Al, Ir, W, Fe, Ni, etc.) which have been used on substrates such as ceramics, steel, Cu, Ti, graphite, and refractory metals in various applications. (Metals Abstr.)

18262 TEN YEARS OF URANIUM PRODUCTION AT ELLWEILER. Feldmann, F.-K. (Ellweiler Uranium Plant, Birkenfeld, Ger.). Atomwirt., Atomtech.; 17: No. 2, 74-7(Feb 1972). (In German).

Uranium production has continued at Ellweiler between Birkenfeld and Nohfelden (Saar) where 13 hectares of area are known to contain a substantial reserve of ore. The processing of the ore is described; size reduction to <1 mm, leaching, filtration, ion exchange on anionic resin, and eventual output of 1,000 kg of dried U_3O_8 per day. By the end of 1970, a total of 135 tons (metric) of U_3O_8 had been produced. (K.S.W.)

18263 APPARATUS FOR MELTING REFRACTORY METALS IN A CONTROLLED ATMOSPHERE. Tsilosani, A. G.; Kashin, V. I.; Samarin, A. M. Fiz. Khim. Obrab. Mater.; No. 2, 147-9 (Mar-Apr 1971). (In Russian).

An improved form of apparatus for the melting of W and other refractory metals is described. The apparatus is based on the use of water-cooled containers etc. made from the same type of metal, thus eliminating the problem of contamination with crucible materials. Molten W, for example, may be held at a temperature of 3500°C or over for 8 minutes without any damage to the apparatus as a whole. The merits of this form of apparatus over its predecessors are discussed. (Metals Abstr.)

18264 SPARK-MACHINED STRUCTURAL PARTS OF NUCLEAR REACTORS. Assmann, H.; Foerner, S. Werkstatt Betr.; 104: No. 1, 1-5(Jan 1971). (In German).

After a general description of the spark-machining process, illustrations of its application to the production of parts from Zr alloys and Cr–Ni austenitic steels are given. (Metals Abstr.)

18265 APPLICATIONS OF THE ELECTROCHEMICAL SURFACE TREATMENT OF METALS IN THE CONSTRUCTION OF PLANT FOR THE CHEMICAL INDUSTRY. Mondon, R. Werkst. Korros.; 22: No. 4, 311-14(Apr 1971). (In German).

The applications and avantages of electrolytic polishing in the chemical and nuclear industries are reviewed. The process maintains the metal structure, enabling reference surfaces for materials and corrosion testing to be prepared, no Beilby layer being formed. Complex shapes can be polished uniformly. (Metals Abstr.)

Properties, Structure, and Phase Studies

Refer also to abstracts 17475, 17678, 17698, 19606, 19638, 19645, 19646, 19650, 19652, 19653, and 19658.

18266 (BARC–562) QUENCH HARDENING IN PURE METALS. Hammad, A. M.; Sharma, B. D.; Rodriguez, P. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 38p. Dep. NTIS (U. S. Sales Only).

Data and mechanism of quench hardening in pure metals are reviewed. Results of the quench hardening behavior of sponge zirconium are also presented. It is found that the quench temperature dependence of the increase in yield stress of zirconium specimens both for α- and β-phases can be represented by a linear log $\Delta\sigma$ Va $1/T_q$ relationship. An examination of the temperature dependence of the yield stress of β-quenched specimens shows that the change in $\Delta\sigma$ is largely "athermal" in nature. Electron microscopic examination of the β-quenched foils also shows that the long range stresses contributing to the "athermal" component can be attributed to an increase in dislocation density and other microstructural changes in the specimens. (auth)

18267 (CEA-R–4264) INTERACTION OF DISLOCATIONS AND HYDROGEN IN NICKEL. Combette, Patrick (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 167p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

An attempt was made to evaluate the interaction between hydrogen and dislocations in an fcc structure identical to that of the stainless steel used for canning nuclear fuels. A series of experiments revealed the anomalous diffusion of hydrogen in Ni between 100 and 230°K; the frequency factor and activation energy, which define the diffusion coefficient of the hydrogen, decrease simultaneously with decreasing temperature. The anomaly observed can be explained in terms of a rudimentary model of the quantum diffusion of hydrogen based on a system with two energy levels (0.41 eV and 0.23 eV). Diffusion limited by the hydrostatic stress imposed by the dislocations is envisaged. This hypothesis seems to be unlikely when it requires a very large proton migration volume. (France)

18268 (COO–3476-1) SLIP INITIATION AND MICRODYNAMICS OF PLASTIC FLOW. Progress Report, January 1–December 31, 1971. Bilello, J. C. (State Univ. of New York, Stony Brook). Contract AT(11-1)-3476. 26p. Dep. NTIS.

Activities in a research program in which several metals and alloys were studied to correlate their defect structure, at a microscopic level, with the observed mechanical behavior of such materials. The information achieved as a result of these observations is relevant to the engineering goals of controlling and improving the mechanical properties of solids. During the past year particular emphasis was placed on the slip limitations at low temperatures for tungsten and to the role of alloying in the strengthening of copper base systems. Results of research are included on microdynamics of W flow, properties of W polycrystals, effects of interstitials on dislocations and mechanical properties of W, and behavior of dislocations in Cu-base solid solutions. (J.R.D.)

18269 (DRI–2573) X-RAY STRUCTURAL ANALYSIS OF METAL–HYDROGEN SYSTEMS. Final Report, 1 February 1970–15 June 1971. Lundin, Charles E.; Sullivan, R. L. (Denver Research Inst., Colo.). Jun 1971. Contract 11-0097. 65p. (SC-CR–715133). Dep. NTIS.

For Sandia Corp., Albuquerque, N. Mex.

The reactivity and subsequent contamination noted in scandium metal- and hydrided-thin films were studied. The phenomenon was found to be primarily a surface effect both at the substrate interface and the outer surface. The reactivity during various types of processing of the substrate interface was observed and characterized. However, the surface area of the thin film was the principal region of interest because of its environmental contamination and the deterrent effect on hydriding to a homogeneous composition. The techniques employed were metallography, x-ray diffraction analysis, and scanning electron microscopy. Various film thicknesses, processing variables, and substrates were investigated. The scandium thin films appeared to be more susceptible to contamination than erbium films, as deduced from the hydriding propensity. Air exposure after preparing the metallic films was the most serious contaminant of the surface. Subsequent hydriding became difficult to conduct resulting in inhomogeneous loading. Studies of means to alleviate hydriding and loading problems resulted in evolving a process of preloading the films with hydrogen in the thin film evaporator. Subsequent air transfer to a hydriding apparatus was found to have less contaminating effect. The sample was then desorbed of the hydrogen and reloaded with hydrogen with greater success than by the simple air transfer and hydriding approach. X-ray diffraction analysis of thin-film scandium hydrides and deuterides was carried out. Sample compositions in both the solid solution region and the dihydride region were subjected to lattice parameter and x-ray density measurements. The data are tabularized and compared with the bulk sample data. The tritium facility was completed during this report period. Subsequently, it was employed to prepare trided erbium and scandium samples for x-ray diffraction analysis. Aging studies of tritided erbium and scandium samples from the previous program were carried out by x-ray diffraction analysis after 24 months for the scandium ditritides and 36 months for the erbium ditritides. Results of tests on these samples indicated no more strain than when checked at 16 months' aging. The new samples that were prepared for aging included both bulk and thin-film specimens of both erbium and scandium. The compositions studied included the solid solution region, the two-phase region, and the dihydride region. The bulk samples were investigated monthly up to about nine months at which point they were transmitted to the x-ray laboratory at the General Electric Co. Neutron Devices Plant for continued studies. The erbium and scandium ditritide phases exhibited an increasing lattice dimension with time up to about three months, and then cyclically increased and decreased several times with an overall increase upward up to nine months. The scandium solid solution alloys showed no aging up to nine months. The thin-film aging studies of the same compositions as the bulk studies were only recently initiated, so not enough time had elapsed to assess the lattice parameter changes. The samples were also submitted to the General Electric Co. for continued analysis. (auth)

18270 (EUR–4740) SOME EXPERIMENTAL RESULTS ON THE SORPTION OF Cs BY SUBMICRON W–10 PERCENT Ta AND Ta POWDERS. De Beni, G. F.; Gautsch, O.; Hodapp, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec 1971. 24p. Dep. NTIS (U. S. Sales Only). EUR FF 4.45.

Submicron W–10% Ta and Ta powders were loaded with Cs at powder temperatures between 600 and 800°C, and Cs-vapor pressures ranging from about 0.01 to 20 mm Hg (sorption-desorption cycles). The Cs saturation loadings were determined by a ^{134}Cs-tracer-method and the corresponding equilibrium pressures of the Cs-vapor were obtained from the temperature of a liquid Cs-reservoir. The pressure-temperature-loading characteristics of the Cs–Ta system showed that the saturation loadings were, at given Cs-pressures, proportional to the oxygen content of the powders, i.e., to the amount of Ta_2O_5. This oxide probably reacts with Cs to form compounds of the type $Ta_2Cs_xO_5$, with x = 2, 4, or 6. (auth)

18271 (IS–2600, pp 125-209) METALLURGY DIVISION. (Ames Lab., Iowa). Dec 1971.

In Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1970–June 1971.

Research and development progress is reported on systems and materials chemistry, deformation behavior of materials, metal purification, structure of materials, diffusion and transport properties, properties of surfaces, materials preparation, and characterization of materials. (J.R.D.)

18272 (LA–4781) SOME MECHANICAL AND PHYSICAL PROPERTIES OF HEAT-TREATED ALLOYS OF URANIUM WITH SMALL ADDITIONS OF Ti OR Mo. Sandstrom, D. J. (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 6p. Dep. NTIS.

Alloys of uranium with small ≤ 1.5 wt % additions of titanium have been investigated at LASL. These alloys have been prepared from castings worked, either by hot rolling or hot extrusion, to yield a wrought structure. The alloys have been heat treated by quenching in water from the gamma region of the phase diagram to yield solution heat-treated alloys. The as quenched material is significantly ductile and strong. After quenching, samples have been subjected to artificial aging treatments, and they seem to undergo an age-hardening reaction. A 30 to 50% increase in yield strength and increased ductility can be measured in samples that have been aged at 400°C for 2 h. These materials do not appear susceptible to stress-corrosion cracking in environments of 100% relative humidity. Their general corrosion resistance is superior to that of unalloyed uranium. (auth)

18273 (LA-DC–13178) LOW-TEMPERATURE EQUATION OF STATE FOR METALS. Merts, A. L.; Magee, N. H. Jr. (Los Alamos Scientific Lab., N. Mex.). [1971]. 11p. (CONF-711208–2). Dep. NTIS.

From Underground nuclear test measurements symposium; Albuquerque, N. Mex. (7 Dec 1971).

Development of methods to provide more accurate equation of state results for pure metals in the melt-vapor region is reported. A code is described which can be used to calculate 1st order phase transition from liquid to vapor state. The code cannot be correctly used for 2nd order phase transitions, such as crystal lattice rearrangements, which alter the equations of state of the element. (J.R.D.)

18274 (LBL–177) STRUCTURE OF VAPOR DEPOSITED 4D TRANSITION METALS. Loop, Richard Bruce (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 38p. Dep. NTIS.

Thesis.

The structures of electron-beam-evaporated 4d transition metals, condensed on a helium-cooled substrate, were observed using the electron microscope. The samples were annealed to room temperature and removed from the substrate prior to the examination. The elements observed were in the range from zirconium to ruthenium, with the samples consisting of pure elements and various binary alloys. Superconducting critical temperatures were also measured. Evidence is presented that it is possible to form transition metals in the amorphous state, irregardless of composition (i.e., compositions including the pure elements, solid-solution alloys, and alloys falling within two-phase regions). The stability of the amorphous phase varies with composition, with the least stability occurring for the pure elements, and the greatest occurring for two-phase regions. The evidence for bcc elements is more conclusive than that for close-packed elements, which present a special case. Amorphous-to-crystalline transformation temperatures were found to be significantly below values previously reported for 3d transition metals in the case of pure elements. In the center of two-phase regions, the transformation temperatures approached 0.3 T_m, in agreement with values reported for nontransition alloys in two-phase regions. (auth)

18275 (MLM–1882) INVESTIGATION OF SUPPLEMENTARY MATERIALS USED IN THE PIONEER RTGS AND CAPSULE SHIPPING CONTAINERS. Zielinski, R. E.; Etter, D. E. (Mound Lab., Miamisburg, Ohio). 12 Jan 1972. Contract AT-33-1-GEN-53. 24p. Dep. NTIS.

The program for investigating the materials used in the Pioneer radioisotopic thermoelectric generator (RTG) and capsule shipping container was initiated when the electrical power output of the RTGs on test at Teledyne Isotopes had decreased to a level below that predicted. The program objective was to determine what material(s), if any, could be released to the internal structure of the RTG and the shipping container from the nonmetallic components of these structures as their temperatures were increased. The materials studied were POCO graphite; pyrolytic graphite; pressed, sintered, and machined ZrO_2; and finally Min-K 1301. Residual gas and thermalgravimetric analyses were the primary methods of investigation. All of the materials were observed to yield organic off-gas products. In addition to the organic materials, the Min-K 1301 also released large quantities of water vapor and hydrogen relative to the other off-gas products. The test results indicated that even a more rigorous outgassing procedure and controlled atmosphere handling of Min-K 1301 could not eliminate the off-gassing of water vapor and hydrogen. The organic material released from the Min-K 1301 seemed to be a residual that remained after the Min-K was outgassed according to specifications. The organic material released by both the POCO and pyrolytic graphite was probably due to storage in plastic bags and a different storage method is recommended. For the ZrO_2, however, more organic outgassing products were observed than for both types of graphite. In addition to the contamination picked up from the plastic bags, it appears that there is some organic residual remaining in the ZrO_2—possibly the binder used during the pressing operation or some type of machining lubricant. (auth)

18276 (ORO–3508-7) DIFFUSION OF GASES IN SOLIDS: TRITIUM DIFFUSION IN AUSTENITIC STAINLESS STEEL AND ZIRCALOY-2; ^{133}Xe DIFFUSION IN SINGLE-CRYSTAL URANIUM DIOXIDE. [Annual Progress Report], November 1, 1970–October 31, 1971. Austin, John; Calder, Richard; Carter, James; Elleman, Thomas; Verghese, Kuruvilla (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering). Contract AT-(40-1)-3508. 77p. Dep. NTIS.

(I) Tritium diffusion in Types 304 and 316 stainless steel and Zircaloy-2 was studied over the temperature range –78 to 222°C by direct measurement of T concentration profiles and surface gas release. Concentration profiles consistent with tritium trapping in specimen surface layers and bulk diffusion were observed in stainless steel and Zircaloy-2, and a rapid diffusion component attributed to grain boundary diffusion was also measured in 304-stainless steel. The bulk and grain diffusion coefficients are given. Surface diffusion coefficients were typically two orders of magnitude below the bulk diffusion coefficients in stainless steel and eight orders of magnitude below bulk values in Zircaloy-2. A preliminary analysis of the expected T diffusion rates through a fuel element cladding showed that diffusion T release should be influenced by the low surface diffusion coefficients. (II) The diffusion release of fission recoiled rare gas ^{133}Xe from single-crystal UO_2 was studied. Methods for eliminating surface effects were used. In the absence of chemical reactions, evaporation, and other surface phenomena and at the lowest gas concentration used, classical diffusion behavior was observed. The classical diffusion coefficients and diffusion parameters were obtained for single-crystal UO_2 in the range 1065 to 1300°C. Gas diffusion measurements conducted with UO_2 single crystals exhibited gas atom trapping at the higher recoiled fission fragment concentrations. The release behavior observed was consistent with a trapping model based on the repeated trapping of the gas atoms at radioinduced defects and release from the traps. (P.C.H.)

18277 (ORO–3908-3) STUDY OF THE STRUCTURE AND MECHANICAL PROPERTIES OF ORDERED ALLOYS. Progress Report, January 1, 1971–December 15, 1971. LeFevre, B. G.; Starke, E. A. Jr. (Georgia Inst. of Tech., Atlanta. School of Chemical Engineering). Contract AT(40-1)-3908. 50p. Dep. NTIS.

Further studies have been conducted on the ordering transformation and some related mechanical properties in Ni_4Mo and CuPt. In the case of Ni_4Mo, x-ray line broadening measurements were extended to kinetic studies at 650°C to supplement earlier x-ray and transmission electron microscopy data. A model for ordering kinetics was developed which can be applied to most ordering systems and permits determination of activation energies. Preliminary internal friction studies indicated that order strengthening in this system is due primarily to interface dislocations at rotational domain boundaries in agreement with the previous conclusion based on x-ray studies. The 3D diffuse scattering associated with short-range order in Ni_4Mo has been measured and is presently being analyzed and corrected for size effect and thermal diffuse scattering. Studies on the order transformation in CuPt have been conducted using microhardness, metallography, electron microscopy, and x-ray diffraction. The transformation was found to be discontinuous at intermediate and low temperatures with a grain boundary component of higher order replacing a homogeneously nucleated fine-domain structure. Preliminary electron microscopy studies of lightly deformed CuPt in the fully ordered condition indicated that some twinning occurs in addition to slip. Super dislocations seemed to be absent for the most part. (auth)

18278 (RLO–2225-T-13-9) STUDY OF PHASE TRANSFORMATIONS AND SUPERCONDUCTIVITY. Annual Progress Report. Polonis, Douglas H. (Washington Univ., Seattle. Coll. of Engineering). 15 Oct 1971. Contract AT(45-1)-2225. 60p. Dep. NTIS.

The experimental program of the past year was concerned with the control of transformation phenomena that could lead to wide variations in the physical and mechanical properties of alloys based on titanium and zirconium. The attainment of reasonable strength coupled with acceptable ductility has been a major practical problem in the utilization of these materials. During the past year the effects of alloy constitution on the superconducting behavior of Ti and Zr alloys were studied and coordinated with the investigation of microstructure and mechanical properties. Results of transformation studies conducted during the past year provide a potential basis for the improvement of both the mechanical properties and the superconducting characteristics of alloys based on Ti and Zr. It was found that aging of the beta phase in quenched alloys at temperatures above the range for omega stability can lead to a phase separation reaction that precedes the nucleation of the alpha phase. Two beta phases form as the result of this reaction, one is rich in solute, termed β_1, while the other is solute-lean and termed β_2. A combination of successive aging and reversion treatments establishes solute-lean and solute-rich regions also termed β_1 and β_2 with the microstructural distribution of the solute-lean regions being determined by the particle distribution of the omega phase formed during the prior aging part of the cycle. Successive aging and reversion treatments have made it possible to maintain a high yield strength coupled with improved ductility in Ti–Cr alloys that otherwise are brittle. In Zr–Nb alloys both of these transformation processes have been shown to contribute to an increase in the superconducting transition temperature from 6.82 to as high as 10.2°K, but the increase depends on the time of the isothermal aging treatment at 550°C that was employed to form solute-rich and solute-lean regions in the beta phase in this system. A systematic analysis of the nucleation and growth processes accompanying the decomposition of the beta phase was made on the basis of free energy diagrams. It was

shown that the observed precipitation of a solute-lean beta phase in certain binary and ternary alloys cannot be explained on the basis of an ordinary miscibility gap. The processes of omega nucleation have been under study with special emphasis being placed on the potential role of stacking faults in the nucleation process. An important result of this work is the observation that repeated aging and reversion treatments inhibit the processes of omega nucleation; the mechanism accounting for this phenomenon will be investigated in greater depth during the coming contract period. The omega phase produced either athermally or by aging increases the yield strength but drastically reduces the ductility of titanium and zirconium alloys. A study of fracture modes was undertaken by means of scanning electron microscopy to resolve the mechanisms of fracture and to establish a basis for improving the toughness and ductility through appropriate transformation processes. The differences in the fracture patterns for the athermal and aged forms of omega were identified with the presence of extensive amounts of strain-induced martensite in alloys containing athermal omega. The superconducting studies of Ti–Cr and Zr–Nb alloys were continued with emphasis on determining the effects of phase separation processes and omega reversion on the inductance transition behavior, including T_c and the shapes of the transition curves. The planning of these experiments has been closely coordinated with the electron microscopy studies in an effort to develop a better understanding of both the microstructural processes and the ways in which they affect the superconductivity properties. Preliminary magnetization studies have been conducted on Ti–Nb and Ti–V alloys subjected to aging and reversion treatments. It was observed that the presence of composition fluctuations in the beta phase of these two systems does not have a significant effect on the magnitude of the magnetic hysteresis. (auth)

18279 (SC-T-713084) PROPERTIES OF SOLID SOLUTIONS OF INTERSTITIAL FOREIGN ATOMS IN VANADIUM, NIOBIUM, AND TANTALUM. Schleaet, F.; Koethe, A.; Rexer, E. Translation of pp 240-53 from report CONF-670222. 24p. Dep. NTIS.

A review is presented of the systems formed by Subgroup V metals and the elements hydrogen, oxygen, nitrogen, and carbon up to the solubility limit, and the diffusion of these interstitially soluble foreign atoms and their influence on the properties using oxygen-containing tantalum as an example. Special attention is given to the strain hardening processes. Results of investigations of the electrical resistivity, Snoek damping, and elastic modulus on cold-deformed Subgroup V metals show that each individual type of foreign atom brings about its own two-step strain hardening process in these metals. With increasing temperature, the interstitial foreign atoms first rearrange themselves in the stress field of the dislocations in such a way that the elastic dipoles assume their most favorable direction with the result that the dislocations at once become weakly pinned. If the interstitial foreign atoms wander, they partially pile up at the dislocations and thus bring the strain hardening process to an end. (auth)

18280 (SC-T-722457) TRANSFORMATION PROCESSES IN SOME URANIUM ALLOYS LOW IN MOLYBDENUM AND NIOBIUM. Castaldelli, L.; Fizzotti, C.; Gandini, A. G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translated for Sandia Labs., Albuquerque, N. Mex., from report RT/MET-(69)2. 39p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 39656.

18281 (SC-T-722458) TRANSFORMATION PROCESSES IN URANIUM ALLOYS WITH 2 PERCENT CONTENTS OF MOLYBDENUM AND NIOBIUM. Castaldelli, L.; Fizzotti, C.; Gandini, A. G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translated for Sandia Labs., Albuquerque, N. Mex., from report RT/MET-(70)2. 36p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 36923.

18282 (SC-T-722461) THERMAL-SHOCK BEHAVIOR OF URANIUM ALLOYS LOW IN ALLOYING ELEMENTS. Fizzotti, C.; Masperoni, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translated for Sandia Labs., Albuquerque, N. Mex.), from report RT/MET-(69)1. 27p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 27056.

18283 (UCRL-Trans-10581) PRESSURE AND TEMPERATURE PHASE DIAGRAM OF URANIUM METAL. Asami, Naoto; Yamada, Masao; Takahashi, Shuichiro. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from J. Jap. Inst. Metals; 31: 389-94(Apr 1961). 18p. Dep. NTIS.

The electrical resistance changes of uranium metal during the transformations between the α (orthorhombic), β (tetragonal), γ (body-centered cubic), and liquid phases have been studied quantitatively up to 80 kb, 1200°C in cooling and heating at rates of 2 to 4°C/sec by utilizing a modified girdle type apparatus. The samples were monitored by thermocouples and potential probes. The pressure temperature (P.T.) locations of the ($\alpha-\beta$), ($\beta-\gamma$), (γ, liquid) and (α,γ) phase boundaries, and ($\alpha-\beta-\gamma$) triple point were determined. The equilibrium ($\alpha-\beta-\gamma$) triple point was placed at 29.8 ± 1.2 kb, 798 ± 5°C. The hysteresis intervals at the heating and cooling runs for $\alpha-\beta$, $\beta-\gamma$ and $\alpha-\gamma$ transformations under high pressures were about 33, 21, and 17°C respectively, and these values were nearly the same as the hysteresis expected at zero pressure. The initial slope of ($\alpha-\beta$) and ($\beta-\gamma$) phase boundaries agreed well with the calculated T. vs P. curve based on the zero pressure thermodynamical consideration. The volume change accompanied with melting was calculated as 0.49 cm^3/mole from the initial slope of (γ, liquid) phase boundary. (auth)

18284 STUDY OF THE HASIGUTI PEAK BY MEASURING THE INTERNAL FRICTION IN Au AFTER WORK HARDENING AND NEUTRON IRRADIATION. Bays, B. (Univ., Lausanne, Switzerland). Mem. Sci. Rev. Met.; 68: No. 9, 629-38(Sep 1971). (In French). (CONF-700941-6).

From Meeting on metallurgy; Paris, France (28 Sep 1970).

The growth and decay of the P_2 Hasiguti peak were studied for 99.999% pure polycrystalline Au samples using an inverse torsion pendulum, a frequency in the 1 Hz region being used. The samples, which were in the form of wires or tubes were generally work hardened by torsional or tensile stressing at 78°K; the growth and decay of the P_2 peak was studied at successively higher temperatures. The recovery associated with the P_2 peak and the dynamic modulus anomaly were measured simultaneously during the growth and decay of the peak. With the wire samples the decay of the P_2 peak is associated with the pinning of dislocations; this pinning arises from clusters of point defects. With tubes, the decay of the P_2 peak occurs simultaneously with an unpinning of the dislocations. The effects of the rapidity and the nature of the work hardening on the form and the temperature at the summit of the peak were investigated. (France)

18285 EFFECT OF STRUCTURE ON THE INTERNAL FRICTION OF NICKEL AND NICKEL ALLOY SINGLE CRYSTALS. Gridnev, V. N.; Kushnareva, N. P. Fiz. Khim. Obrab. Mater.; No. 2, 75-9(Mar-Apr 1971). (In Russian).

The temperature dependence of the internal friction of Ni, Ni–1 at. % Mo, and Ni–Mo Permalloy was studied at temperatures up to 1000°C by the torsional vibration method and the results were correlated with the structure of the corresponding materials. Fragmentation effects taking place in the Ni yielded a wide maximum at 650°C. The experimental parameters of this peak and the corresponding effects in the alloys agreed closely with those predicted by dislocation theory. (Metals Abstr.)

18286 PHASE COMPOSITION OF IRON/ALUMINUM WELDS CONTAINING HOLMIUM. Ryabov, V. R.; Zarechnyuk, O. S.; Rabkin, D. M.; Vivchar, O. I. Avtomat. Svarka; No. 7, 76-7(Jul 1971). (In Russian).

With a view to increasing the strength of Fe/Al welds by adding Ho to the Al constituent, the phase composition of a number of welds effected between Fe and Al–Ho alloys was studied, both by optical microscope analysis and also x-ray diffraction. A number of binary and ternary phases were formed in these welds; the phases included $HoFe_4Al_8$, $Ho_2Fe_{11}Al_8$, Ho_2Fe_{17}, Fe_4Al_{13}, Fe_2Al_5, $FeAl_2$, and FeAl. The relationship between these phases in the Fe–Al–Ho phase diagram is considered together with their respective influence on the properties of the welds. (Metals Abstr.)

18287 DISTRIBUTION OF DEFORMATION IN METALS AND ALLOYS AFTER UNDERGOING HYDRAULIC EXTRUSION. Buinov, N. N.; Karakhanyan, R. A.; Romanova, R. R.; Bulychev, D. K.; Rodionov, K. P. Fiz. Metal. Metalloved.; 31: No. 2, 304-10(Feb 1971). (In Russian).

The distribution of deformation in various metals and alloys (Mo, W, etc.) subjected to hydraulic extrusion was studied by examining thin films under the electron microscope and analyzing hardness measurements. The uniformity of the distribution varied considerably from one material to another; for each material there was an optimum degree of friction between the die and the extruded sample ensuring a comparatively high degree of uniformity. These results were supported by an analysis of the dislocation structure of Mo and W specimens after undergoing hydraulic extrusion. (Metals. Abstr.)

18288 THERMODYNAMICS OF LIQUID PRASEODYMIUM–INDIUM ALLOYS. Degtyar, V. A.; Bayanov, A. P.; Vnuchkova, L. A.; Serebrennikov, V. V. (Siberian Metallurgical Inst., Novokuznetsk, USSR. Tomsk State Univ., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 7, 1032-3(Jul 1971).

Translated from Zh. Fiz. Khim.; 45: No. 7, 1816-17(Jul 1971).

The thermodynamic properties of praseodymium–indium alloys have been investigated by an emf method in the range 725 to 975°K for praseodymium contents up to 8 wt.%. The partial molar and integral thermodynamic characteristics of the liquid alloys and of the compound $PrIn_3$ have been calculated. The solubility of praseodymium in liquid indium has been determined. (auth)

18289 PHASE DIAGRAM FOR INDIUM. Fadeev, V. E. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 7, 1051-2(Jul 1971).

Translated from Zh. Fiz. Khim.; 45: No. 7, 1843-4(Jul 1971).

The phase diagram for indium has been plotted up to 7500 atm with the aid of a very accurate method, developed by the author. A singularity has been observed on the fusion curve and has been attributed to a polymorphic transition in solid indium from a face-centered hexagonal structure to a face-centered cubic structure. (auth)

18290 REVIEW OF RECENT INVESTIGATIONS IN JAPAN ON THE BRITTLE FRACTURE OF PRESSURE VESSEL STEELS. Kihara, H. (Tokyo Univ.).; Kanazawa, T.; Ando, Y.; Machida, S.; Ikeda, K. At. Energy Rev.; 9: No. 4, 687-786(Dec 1971).

A review is made of the brittle fracture of reactor pressure vessel steels, mostly based on the results of studies by Japanese researchers. After a short introduction to this field, the effects of various factors on the initiation as well as the propagation and arrest of brittle fracture are described in detail. The WES-136 evaluation standard for structural steels for low-temperature applications is explained. The future needs of further studies are discussed. (auth)

18291 THERMOPHYSICAL PROPERTIES OF VANADIUM AT HIGH TEMPERATURES. Peletskii, V. E.; Druzhinin, V. P.; Sobol, Ya. G. (Inst. for High Temperatures, Moscow). High Temp. - High Pressures; 3: No. 2, 153-9(1971).

A study is reported of the thermal conductivity, electrical resistivity, emissivity, and specific heat of polycrystalline vanadium in the temperature range from 1200 to 1800°K, which involved heating of the specimen by electron bombardment. The method and apparatus used are described, and the results are discussed and compared with data reported in the literature. (auth)

18292 SOLUBILITY OF IRON IN INDIUM. Malyugin, A. S.; Pogorely, A. D. Tr. Severokavkaz. Gornomet. Inst.; No. 28, 58-9(1970). (In Russian).

Microstructural, x-ray, thermal, and chemical analyses were used to study the solubility of Fe in In in the range 200 to 1100°C. At room temperature the solubility of Fe in In and of In in Fe was extremely low. (Referativnyi Zh.)

18293 STRAIN RATE EFFECTS IN BRITTLE MATERIALS. Mardirosian, Milton M.; Riffin, Paul V. ASM Technical Report No. C70-16.3. Metals Park, Ohio; American Society for Metals (1970). 42p. $3.00.

Strain-rate effects at room temperature and elevated and subzero temperature were noted over a wide variety of both tough and brittle materials including 4340, 52100, and HF-1 steels, 6 Al–4 V, and 6 Al–6 V–2 SnTi alloys and 8 Mo–0.5 Ti–U alloy. Mechanical property characteristics of these materials as a function of strain-rate include such parameters as true-stress, true-strain, true fracture stress, ultimate and yield strengths, tension modulus, and reduction of area. The strain rates studied in these tests ranged from 10^{-3} in./in./s to 530 in./in./s. (Metals Abstr.)

18294 PHYSICOCHEMICAL INTERACTIONS AND PROPERTIES OF ALLOYS OF NICKEL–RHENIUM CONTAINING GROUP IIIA ELEMENTS. Arskaya, E. P.; Tylkina, M. A.; Savitskii, E. M. pp 50-9 of Renii v Novoi Tekhn. Part 2. Moscow; Izdatel'stvo Nauka (1970). (In Russian).

Physicochemical interactions and phase transformations were studied with the binary Ni–Re and ternary Ni–Re–Sc, Ni–Re–V, and Ni–Re–La systems. The regions of the ternary solid solutions were established. Other properties studied included hardness, electrical conductivity, and UTS. (Referativnyi Zh.)

18295 MICROPROBE STUDY OF TITANIUM–BERYLLIUM COMPOSITE. Raymond, L.; Kendall, E. G. TMS Paper No. F70-3. New York; American Institute of Mining, Metallurgical, and Petroleum Engineers (1970). 12p.

Titanium–beryllium composites have been produced by coextrusion of powders to form a powder metallurgy composite with a microstructure that cannot be produced by conventional melting practices. Microprobe studies were conducted to evaluate the thermal stability of the microstructure up to 1275°K. After 6 hr at 810°K, the microstructure remained stable but, at 1025°K, the two metals began to react, with the Be diffusing into Ti much more rapidly than vice versa, as evidenced by void formation. A layer of titanium beryllide, $TiBe_2$, encapsulates the voids. The details of the microprobe studies are discussed and the potential of the system is compared to other composite systems based on preliminary mechanical property measurements. (Metals Abstr.)

18296 TEMPERATURE/VELOCITY RELATIONSHIPS FOR THE STRENGTH AND DUCTILITY OF LUTETIUM. Solenov, V. M.; Skudnov, V. A.; Sokolov, L. D.; Gladkikh, A. N. Probl. Prochnosti; No. 8, 61-3(Aug 1971). (In Russian).

A simplified method of studying the effects of temperature and strain velocity on the strength and ductility indexes of metals is described, together with a practical application to the case of Lu. There is a general tendency for the ductility of this metal to rise with increasing temperature; however, an anomalous region occurs in the neighborhood of $0.3T_m$(T_m = m.p.), in which this tendency is temporarily reversed; the anomalous region is attributed to a form of strain aging. The practical significance of these effects in relation to the working of Lu is considered. (Metals Abstr.)

18297 EFFECTS OF HEAT TREATMENT ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF COPPER–1.9 PERCENT BERYLLIUM–0.2 PERCENT COBALT ALLOY. Yoon, Young K.; Yoo, Yeon C.; Choi, In H. J. Korean Inst. Metals; 9: No. 1, 1-10(Jun 1971). (In Korean).

The effects of heat treatment on the mechanical properties and microstructures of a Cu–1.9% Be–0.2% Co spring alloy were studied. Optimum mechanical properties were obtained for specimens treated by 35% final cold-reduction, aged for 2 hr at 330°C after solution heat treatment at 800°C for 15 min. Thin-foil transmission electron microscopy established the aging sequence as $\alpha \rightarrow$ G.-P. zones $\rightarrow \gamma' \rightarrow \gamma$ within the grains and $\alpha \rightarrow \gamma$ at the grain boundaries. (Metals Abstr.)

18298 IMPACT STRENGTH AND COLD-SHORTNESS THRESHOLD OF MOLYBDENUM. Gulyaev, A. P.; Morgunova, N. N.; Malkhasyan, N. M. Probl. Prochnosti; No. 8, 70-3(Aug 1971). (In Russian).

The cold-shortness threshold of notched Mo samples was studied by analyzing the results of impact tests. Changing the notch radius from 0.1 to 1.0 mm had hardly any effect on the cold-shortness temperature for either worked or recrystallized samples. In testing worked samples, however, a slight complication was noted: below the cold-shortness threshold the sample only suffered brittle fracture over part of its cross section; the rest bent plastically, the proportion of ductile material diminishing with falling temperature. Possible reasons for this effect are discussed. (Metals Abstr.)

18299 VOID GROWTH UNDER APPLIED STRESS. Li, Che-yu (Cornell Univ., Ithaca, N. Y.); Nolfi, F. V. Jr. Scr. Met.; 6: No. 1, 17-20(Jan 1972).

The mechanisms by which strain energy terms are related to boundary conditions in diffusional processes are described. The discussions apply to diffusion controlled void growth under stress conditions at high temperatures under which radiation effects are not important. The concentration of thermal vacancies is greater under these conditions than that of the vacancies produced by displacement damage. (J.R.D.)

18300 PRECIPITATE SUBSTRUCTURE AND FATIGUE OF Cu 1.9 WT. PERCENT Be. Bonfield, W. (Queen Mary Coll., London). Scr. Met.; 6: No. 1, 77-80(Jan 1972).

Results of fatigue strength tests on polycrystalline Cu–1.9 wt % Be–0.2 wt % Co alloys are reported. The alloys were prepared under conditions such that a range of precipitate structures were obtained for the tests. A transition in the dependence of fatigue strength on precipitate structure when the applied stress level exceeds that required for dislocations to cut through precipitate particles was indicated. (J.R.D.)

18301 INTERFACE REACTION AND A SPECIAL FORM OF GRAIN BOUNDARY DIFFUSION IN THE Cr–W SYSTEM. Den Broeder, F. J. A. (Technological Univ., Delft, Netherlands). Acta Met.; 20: No. 3, 319-32(Mar 1972).

The two-phase diffusion between chromium and tungsten, forming bcc solid solutions, was followed from the beginning by means of a special x-ray diffraction technique, optical microscopy, and electron microprobe analysis. It appears that in a first stage only tungsten diffuses into the chromium, while the tungsten remains pure. The Kirkendall-effect however indicates that chromium is the much more rapidly diffusing component. It is shown that these two observations are not contradictory. In this stage the Cr-rich alloy can dissolve more tungsten than the equilibrium value; a thermodynamic explanation of this effect is given. A second stage

consists of the formation of a W-rich alloy of a distinct composition in a discontinuous way at separate sites of the interface, presumably by an interface reaction. At the junction of the interface and a tungsten grain boundary a special form of grain boundary diffusion occurs, during which the grain boundary most likely moves away from its initial position, as in the case of discontinuous decomposition. The experimental results are discussed in the form of an atomic description of the various phenomena, by taking into account the enormous difference in melting point of chromium and tungsten. This difference leads to a model of the atom and vacancy jumps at the interface right from the beginning of the diffusion; this model is based upon a much higher vacancy concentration in chromium compared to tungsten and a much greater mobility of the chromium atoms. From the considerations an "incubation time," during which the motion of Kirkendall-markers is delayed, might be expected. An analogous atomic model has been used to give a description of the mechanism, by which the special form of the diffusion of chromium along a tungsten grain boundary occurs. In this boundary, treated as a phase with a very high vacancy concentration, it is proposed that a reaction should take place, leading to the deposition of a tungsten-rich W–Cr alloy, epitaxially to the adjacent chromium crystallite or to one of the adjacent tungsten crystallites. As a result the initial grain boundary will split into two boundaries or will move away from its original position. (auth)

18302 REACTION OF SOME TRANSITION METALS OF GROUPS IV–VII WITH RHENIUM AND BORON. Kuz'ma, Yu. B.; Telegus, V. S.; Lakh, V. I.; Stadnyk, B. I.; Kovalyk, D. A. pp 21-5 of Renii v Novoi Tekhn. Part 2. Moscow; Izdatel'stvo Nauka (1970). (In Russian).

Isothermal sections were constructed from x-ray and microstructural analyses of the systems (i) Zr–Re–B, (ii) Hf–Re–B, (iii) V–Re–B, (iv) Nb–Re–B, (v) Cr–Re–B, (vi) Mo–Re–B, (vii) W–Re–B, and (viii) Re–Mn–B. No ternary compounds were found in (i) or (ii) but in (vii) three such compounds were detected corresponding to $V_{0.95-0.63}Re_{1.05-1.37}B$, $V_{0.51-0.36}Re_{1.49-1.64}B$, and $V_{0.4}Re_{0.6}B$. In (iv) the phase $Nb_3Re_3B_4$ occurred. No significant amounts of binary-compound-based solid solution were detected in either of the systems (iv) and (vii). The compounds $Cr_{3.5-3.0}Re_{1.5-2.0}B_5$ and $CrRe_3B_{4-x}$, which broke down after annealing, were present in (v). There was appreciable solubility of Re in Cr_2B. In (vi) and (vii) compounds were found with the structure type $Mn_8(Mo_{4.5}Re_{15.5}B_{22}$ and $W_{6.7}Re_{13.3}B)$ which also broke down after annealing. The system (vi) had a significant quantity of a third component in the lower borides. System (vii) had a wide range of solid solutions based on W and Re borides. The existence of the τ phase $Re_{14.5-4.35}Mn_{8.5-18.65}B_6$ in (viii) was confirmed and a new compound Re_3MnB_2 found. There was significant solubility of Re in Mn_2B and in MnB. The conditions for ternary compound formation in transition metal–Re–B systems were studied. (Referativnyi Zh.)

18303 SURFACE SATURATION [BY CARBON, BORON, OR SILICON] OF THE MAGNETICALLY HARD [IRON–NICKEL–ALUMINUM–COBALT] ALLOY YuNDK35T5 [IN RELATION TO MACHINABILITY]. Goncharova, V. V.; Lyapichev, I. G.; Byzov, Yu. M.; Chesnokov, Yu. V.; Shtern, T. N. Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 4, 116-21(1971). (In Russian).

The surface saturation of magnetically hard Fe–Ni–Al–Co alloys of the YuNDK35T5 class with C, B, and Si was studied together with the effects of these surface additives on the machining properties of the material as a whole. Thus the depth and hardness of the surface layer was sensitive to the relative amounts of additives employed and the parameters of the chemico-heat treatment used in order to achieve surface saturation. Subject to optimum choice of these parameters, surface saturation greatly improved the machining properties of the alloy, particularly its response to processing with abrasive grinding wheels. (Metals Abstr.)

18304 STRUCTURES OF INTERMETALLIC COMPOUNDS IN THE CADMIUM–ANTIMONY AND ZINC–ANTIMONY SYSTEMS. Aleinikova, K. B.; Ignat'ev, N. A.; Ugay, Ya. A.; Marshakova, T. A. Tr. Voronezh. Gos. Univ.; 74: 21-5(1971). (In Russian).

X-ray analyses were used for precise determination of the structures Cd_4Sb_3 and Zn_4Sb_3. Determinations were also made of the crystal lattice type of Cd_3Sb_2, ξ-Zn_3Sb_2, and η-Zn_3Sb_2. (Referativnyi Zh.)

18305 EFFECT OF TEMPERING TEMPERATURE ON STRUCTURAL TRANSFORMATIONS IN CAST NICKEL–CHROMIUM ALLOYS ALLOYED WITH NIOBIUM AND MOLYBDENUM. Ionkina, E. M.; Lebedev, K. P. Tr. Leningrad. Politekh. Inst.; No. 319, 114-18(1971). (In Russian).

Factors leading to structure transformations in Ni-base 15% Cr alloys containing Nb and Mo were studied. Depending on the temper temperature and Nb content the strengthening of cast quenched Ni–15% Cr–Nb alloys was caused by the precipitation of a secondary strengthening phase with dispersed or acicular shapes. The addition of Mo 5, 10, and 15% to Nb containing alloys accelerated the breakdown of the supersaturated Ni–Cr solution and the transformation of the disperse metastable phase into a uniform acicular phase. (Referativnyi Zh.)

18306 BOILING POINT OF URANIUM. Randol III, A. G. (Nuclear Fuel Services, Inc.); Schneider, R. T.; Kylstra, C. D. pp 181-5 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Current techniques for boiling-point determinations rely on extrapolation of low-temperature vapor pressure data (usually collected below 2500°K) through the Clausius–Clapeyron equation. Since the temperature limitation is, in most cases, difficult to overcome, it is necessary to rely heavily on indirect methods for the evaluation of boiling points. Under special environment conditions there is evidence that an interpretation of uranium plasma electrical characteristics can lead to reasonable estimates of the boiling point. The device used to generate the uranium plasma, a high-pressure uranium arc, is described. Details of the electrical power, cooling, high-pressure gas, and data-acquisition systems are given. A modification of the Nottingham equation for electric arc potential versus current is presented. The application of this arc electrical characteristics model is discussed in terms of the determination of the boiling point of the uranium anode. The evaluated boiling points of uranium between 1 and 7 atm are compared with the extrapolations of other authors. (auth)

18307 SATURATION OF METAL [NIOBIUM, ETC.] WITH ARGON IMPURITIES. Dushin, Yu. A.; Mikhailov, S. K.; Sokolova, G. V.; Borisov, A. Ya. Fiz. Khim. Obrab. Mater.; No. 3, 24-8(May-Jun 1971). (In Russian).

The problem of the non-stationary dissolution of traces of Ar in heated metal plates placed in a rapid flow of this gas is discussed from the theoretical and experimental points of view. Two different processes are involved: dissolution in a thin layer of metal close to the surface and dissolution extending over the whole volume. Thus in the case of Nb the amount of Ar dissolving close to the surface largely depends on the amount of N it contains. The results of tests on Nb at 1300 to 1800°C are presented by way of illustration. (Metals Abstr.)

18308 CONCENTRATION DEPENDENCE OF THE THERMAL TRANSPORT OF NITROGEN IN TANTALUM. Hoefer, Gerhard (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Naturforsch.; 26a: No. 11, 1885-7(Nov 1971). (In German).

In a temperature gradient nitrogen atoms migrate to the hot region. The heat of transport is negative and depends on the concentration. If the concentration of the dissolved atoms is higher than 1 at. %, its value is about –1 kcal/mol; however, it increases to –7 kcal/mol for an infinitely dilute solution. This value seems to be more convenient for a comparison with data of other systems and theoretical considerations. (auth)

18309 FATIGUE STUDIED AS A STATISTICAL WORK-HARDENING PHENOMENON. Kettunen, P. O.; Knocks, U. F. (Tampere Univ. of Tech., Finland). Acta Polytech. Scand., Chem. Met. Ser.; No. 104, 1-23(1971).

Fatigue is explained on the basis of work-hardening using the ideas of a statistical theory of slip. Work-hardening in copper single crystals was studied under prescribed stress as well as strain amplitudes. A conclusion is drawn that cyclic deformation can be divided into two regions: one in which straining is controlled by "cyclic hardening," i.e., by the entire history from the beginning of cycling; the other in which straining is controlled by the "instantaneous" work-hardening occurring during the half-cycle in question. An eventual fracture seems to require that the yield strength during cycling reaches the value of the dividing stress amplitude between the two regions. In the two models, this becomes possible at different applied stress amplitudes, which is also reflected in the corresponding S–N curves. The existence of an endurance limit, and the likelihood of crack initiation from the surface are explained on this basis. A competitive equation for the Coffin–Manson law is suggested. (auth) (Finland)

18310 NUCLEATION OF ATOMIC STEPS ON INERT GAS BUBBLES INTERSECTED BY DISLOCATIONS. Beere, W. B. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag.; 25: No. 1, 189-200(Jan 1972).

The diffusivities of small polyhedral bubbles attached to dislocations in copper thin foils were calculated from observations of the

distances migrated and the rate of diffusion to the foil surface during isothermal annealing. It was shown that when few collisions occur between bubbles the bubble diffusivity could be easily calculated from the experimental data. The bubble diffusivities were satisfactorily described by a rate-controlling nucleation mechanism, in which ledges introduced into the bubble surface by the dislocation rotated about the dislocation, causing the bubble to migrate. The model predicted that bubbles intersected by dislocations would have higher diffusivities than bubbles in a perfect lattice. (auth)

18311 ELECTRIC TRANSPORT AND ELECTRON PROPERTIES OF THE MOLTEN BINARY METALLIC SYSTEMS MERCURY–THALLIUM AND THALLIUM–INDIUM. Belashchenko, D. K.; Gushchina, E. I.; Omarova, K. D. Fiz. Metal. Metalloved.; 31: No. 5, 930-8(May 1971). (In Russian).

Electric transport phenomena taking place in alloys of the Hg–Tl and Tl–In systems at 300 and 380°C, respectively, were studied, together with the electric resistance of the Tl–In alloys at the test temperature. By analyzing the results, together with published data, the relative density-of-states of the Hg–Tl and Tl–In systems at the Fermi level was expressed as a function of composition. The evidence suggested that the Tl ions had a charge of three units for all compositions studied. (Metals Abstr.)

18312 EFFECT OF PRELIMINARY ARTIFICIAL AGING OF A COPPER–BERYLLIUM ALLOY ON SUBSEQUENT NATURAL AGING. Yamaleev, K. M.; Agishev, V. M. (Inst. of Geology, Ufa, USSR). Fiz. Metal. Metalloved.; 31: No. 6, 1313-15(Jun 1971). (In Russian).

The natural aging of Cu–Be alloys at 20°C over periods of many years was compared with the natural aging of similar samples which had first been subjected to brief artificial aging (5 to 30 min at 300°C). The preliminary artificial aging sharply reduced the rate of natural aging, so that effects which appeared after 5 y in samples not so treated failed to appear after 14 y in the material subjected to preliminary artificial aging. Similar effects occurred in the case of Al–Zn alloys. (12 references) (Metals Abstr.)

18313 GRAIN-SIZE INFLUENCE ON THE COLD BRITTLENESS OF BERYLLIUM. Ivanov, V. E.; Tikhinskii, G. F.; Shpagin, I. V.; Khristenko, I. N. (Physical-Technical Inst., Kharkov). Fiz. Metal. Metalloved.; 31: No. 6, 1281-5(Jun 1971). (In Russian).

The temperature of the ductile → brittle structural transformation in high-purity (99.95%) Be and Be of commercial quality was studied in relation to grain size. The critical brittleness temperature obeyed a relation of the $T = A + Bd^{\frac{1}{2}}$ type, where d = grain size and A and B are constants. The critical temperature was appreciably lower in the case of the high-purity Be. The ultimate tensile strength and yield strength close to the critical temperature were correspondingly dependent on grain size. The mechanisms underlying these effects are considered. (Metals Abstr.)

18314 EFFECT OF IMPURITIES ON THE COLD BRITTLENESS OF BERYLLIUM. Ivanov, V. E.; Tikhinskii, G. F.; Shpagin, I. V.; (and others) (Physical-Technical Inst., Moscow). Fiz. Metal. Metalloved.; 31: No. 6, 1286-92(Jun 1971). (In Russian).

The critical brittleness of Be samples of various degrees of purity was studied in relation to the impurity content (qualitative and quantitative). The temperature corresponding to the onset of the transformation from the ductile to the brittle state fell on reducing the impurity content. With diminishing proportion of impurities, the contribution of twinning to the overall deformation of the material became less substantial. The ultimate tensile strength of Be increased with increasing purity. (21 references) (Metals Abstr.)

18315 HEAT RESISTANCE OF NICKEL-BASE WELDS. Bridavskii, M. S.; Zemzin, V. N.; Pigrova, G. D.; Demyantsevich, S. V. Fiz. Khim. Obrab. Mater.; No. 4, 117-23(Jul-Aug 1971). (In Russian).

The effects of composition on the heat resistance of Ni-base welds were studied. Thus Ni–Mo welds had better properties in this respect than Ni–Nb welds. However, there was a tendency for brittleness to develop in the Mo-containing material as a result of the precipitation of a Mo-rich μ phase; this appeared in considerable quantities in the simultaneous presence of Fe and Si when the Mo content of the alloy exceeded the solubility limit of Mo in the matrix. (Metals Abstr.)

18316 STRUCTURE OF NONCRYSTALLINE Co-25 a/o W ELECTRODEPOSIT. Omi, T. (Univ. of Osaka Prefecture, Sakai, Japan); Yamamoto, H.; Glass, H. L. J. Electrochem. Soc.; 119: No. 2, 168-73(Feb 1972).

Noncrystalline electrodeposits of Co-25 at. % W prepared from ammoniacal alkaline tartrate electrolyte were studied by x-ray diffraction. A model for the structure of this alloy was developed. The principal assumptions involved in constructing the model were based mainly on requirements for the electrodeposition. The model requires that the alloy consist of distinct basic structural units in the form of tetrahedra, each composed of three cobalt atoms and one tungsten atom. The dimensions of this structural unit correspond to those of the intermetallic compound Co_3W. Certain criteria govern the bonding of the tetrahedra to form larger aggregates. The scattering function calculated from the model agree quite well with the diffraction data. The model also accounted for differences in the composition of amorphous deposits prepared at different current densities. The electrochemical requirements for the formation of this structure by electrodeposition are discussed. The operation of similar processes in the electro- or chemical deposition of other alloys having stoichiometric composition was considered. (auth)

18317 HIGH-SPEED (SUBSECOND) MEASUREMENT OF HEAT CAPACITY, ELECTRICAL RESISTIVITY, AND THERMAL RADIATION PROPERTIES OF NIOBIUM IN THE RANGE 1500 TO 2700 K. Cezairliyan, Ared (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 75A: No. 6, 565-71(Nov-Dec 1971).

Measurements of heat capacity, electrical resistivity, hemispherical total emittance, and normal spectral emittance of niobium in the temperature range 1500 to 2700°K by a subsecond duration pulse heating technique are described. Results obtained on these properties are reported and are compared with those in the literature. A sharp increase in heat capacity above 2000°K was observed. Electrical resistivity showed a negative departure from linearity in the curve of electrical resistivity against temperature. Estimated inaccuracy of measured properties is: 2 percent for heat capacity, 0.5 percent for electrical resistivity, and 3 percent for hemispherical total and normal spectral emittances. (auth)

18318 NICKEL- AND COBALT-BASE ALLOYS. Drennen, D. C. DMIC Rev.; 6p(6 Aug 1971).

Recent research on Ni and Co alloys includes work on: the effect of dynamic deformation on the microstructure and mechanical properties of aged Udimet 700; powder metallurgy processes for low interstitial Ni superalloy powders; applications of FA-375 and AF2-1DA Ni superalloys; a vacuum melted Co–W alloy (VM-108) modified for improved stability at intermediate temp; extrusion and corrosion problems in Co–20 Ni–18 Cr–2 ThO_2 and Co–20 Ni–30 Cr–2 ThO_2 alloys; indirect dispersed particle strengthening in Ni–2 ThO_2, Ni–20 Cr–2 ThO_2, Ni–20 Cr–10 W–2 ThO_2, Ni–20 Cr and Ni–20 Cr–10 W alloys; improved diffusion coatings based on Al for Ni and Co alloys used in gas turbines; methods for field repair of aluminide diffusion coatings on Ni-base turbine blade alloys; slurry coatings for In-100 and WI-52 alloys; characteristics of 11 Co–Cr–Al–Y, Co–Cr–Ni–Al–Y, and Co–Cr–Fe–Al–Y coatings applied to Ni alloys by electron-beam vapor deposition; the diffusion coating of TD Ni with duplex Cr/Al; the effect of surface condition on the static air oxidation behavior of a Co superalloy at 1800 to 2000°F; the oxidation behavior of WI–52 Co and IN–100 Ni alloys; hot corrosion of coated and uncoated superalloy turbine blades; and fracture and subcritical growth characteristics of forged and electron-beam welded Alloy 718 tankage material in high-pressure gaseous and liquid O. (Metals Abstr.)

18319 SCIENCE, TECHNOLOGY, AND APPLICATION OF TITANIUM. Proceedings of an International Conference Held at London, 21–24 May 1968. Jaffee, R. I.; Promisel, N. E. (eds.). Oxford; Pergamon Press Ltd. (1970). 1219p. $48.00. (CONF-680542).

One-hundred-thirteen papers are included. A separate abstract was prepared for each of 68. One article on hot-salt stress corrosion cracking of Ti alloys was previously included in NSA as 23: 14295. The remaining 44 papers contain information on: processing of Ti; chemical and environmental behavior of Ti; stress corrosion cracking of α-Ti alloys; crystallography of intermetallic compounds and Ti alloys; deformation and fracture of Ti and Ti–Al crystals; phase transformations and heat treatment of Ti and its alloys; age hardening reaction in Ti–Cu; structure and mechanical properties of Ti welds; properties and application of Ti–5Al–2Cr–1Fe; submerged arc welding of Ti; explosive bonding and forming of Ti; and applications experience on Ti in jet engines, aircraft engines, aircraft structures, and process industries. (P.C.H.)

For abstracts of individual papers see: 18197–18205, 18244–18253, and 18320–18368.

18320 APPLICATION OF SOLIDIFICATION THEORY TO TITANIUM ALLOYS. Brody, Harold D.; David, S. A. (Univ. of Pittsburgh). pp 21-34 of Science, Technology, and Application of

Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

New concepts of solidification theory, pertinent to titanium alloys were reviewed, and a need was shown for the development of solidification data on titanium alloys. Microsegregation in some binary titanium alloys has been predicted on the basis of existing theory. Measurement of microsegregation has been made in only one alloy, Ti–6Al–4V, but found to be below detectable limits by either electron probe techniques or microradiography. Specialized types of segregation have been observed in as-cast (CEM) Ti–6Al–4V: vanadium enrichment at grain boundaries; and slight aluminum enrichment in random patches about $\frac{1}{32}$ in. in diameter. However, the characterization of this segregation is not definite. These observations are considered indications of possible segregation effects rather than descriptions of generally occurring casting defect. Macrosegregation in CEM has been reviewed in light of recent theories of macrosegregation in ingots. Three mechanisms for segregation in CEM have been proposed and should be checked experimentally. (P.C.H.)

18321 RESEARCH ON THE QUALITY OF COMMERCIALLY PURE TITANIUM AND Ti–6Al–4V INGOTS. DeTemple, E.; Gerhardt, A.; Knorr, W. (Fried-Krupp GmbH, Essen)]. pp 35-41 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Research was made on the homogeneity of large commercially pure Ti and Ti–6Al–4V because of a change in ingot size from 1,000 to 5,000 to 10,000 kg. Averages of the oxygen content and the hardness of the ingots and the tensile strength of forged samples were compiled for four different grades. The results showed that the average value of the scatter of the ingots was generally smaller than the standard deviation of the averages, which is significant for the grades and in respect to the tensile strength was much smaller than the specified tolerance limits. An exception was the oxygen content. For a commercially pure titanium grade with a tensile strength of 39.6 kp/mm^2 a standard deviation of the tensile strength of 1.5 kp/mm^2 was found, which is within the order of magnitude of the corresponding values. The results on Ti alloys showed that homogeneous Ti–6Al–4V ingots up to 5000 kg and a diameter of 680 mm may be produced. (P.C.H.)

18322 CHEMICAL AND STRUCTURAL MICROINHOMOGENEITY, DIFFUSION, AND MECHANICAL PROPERTIES OF TITANIUM ALLOYS IN CONNECTION WITH PHASE TRANSFORMATION CHARACTERISTICS. Bokshtein, S. Z.; Emelyanova, T. A.; Kishkin, S. T.; Mirskii, L. M. (Moscow Aviation Inst., Moscow). pp 43-56 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Conditions for formation of chemical microinhomogeneity, means of its removal, its relation to the structure, mechanical properties, and atom diffusion mobility were investigated. Commercial Ti alloys (VT5, VT10, VT3-1, VT20, OT4) as well as I and commercial purity Ti and the binary alloys with Mn, Fe, Mo, and Ni were studied. The principal investigation method used was qualitative and quantitative autoradiography, based upon photographic action of radiations. ^{63}Ni and ^{14}C were used as tracers. In all materials investigated a concentration microinhomogeneity after slow or moderate cooling from the β-region appeared. It was also found in a series of experiments that microinhomogeneity depends on cooling conditions. The extent of concentration inhomogeneity increased as the cooling rate diminished. The foreign atom migrations accompanying the phase transformation seemed to be accomplished by diffusion events. It was concluded that the influence of microinhomogeneity on the high-temperature properties of alloys may be judged from the results of C and Ni diffusion investigation in the α-phase VT5 alloy after different heat treatments. (P.C.H.)

18323 BETA FORGING OF TITANIUM ALLOYS. Coyne, J. E. (Wyman-Gordon Co., Worcester, Mass.). pp 97-110 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies on the β forging of U.S. and U.K. alloys showed improved forgeability in all alloys investigated. The silicon containing U.K. alloys showed no significant loss of tensile properties whether beta forged or beta heat treated. The non-silicon-containing U.S. alloys showed varied response to beta heat treatment. Forging temperatures for the U.K. alloys were restricted to about 100 to 150°F above the $\alpha + \beta/\beta$ transus due to pronounced silicide segregation at prior beta grain boundaries. U.S. non-silicon-containing alloys have been forged on a production basis as high as 300°F above the $\alpha + \beta/\beta$ transus. All alloys showed significantly improved tensile ductility when given an $\alpha + \beta$ solution treatment after β forging. Both IMI 684 and Hylite 65 showed high fracture toughness but limited data indicated more experimental work is needed with the U.K. alloys. (auth)

18324 EFFECT OF BETA PROCESSING ON PROPERTIES OF TITANIUM ALLOYS. Green, T. E.; Minton, C. D. T. (Imperial Metal Industries (Kynoch), Ltd., Birmingham, Eng.). pp 111-19 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Data obtained primarily from U.K.-developed Ti alloys, illustrating the effect on properties of heating above the β transus at intermediate and final stages of processing are presented. The alloys discussed include: Ti–6Al–4V, (IMI 318); Ti–4Al–4Mn (IMI 314); Ti–11Sn–2.25Al–5Zr–1Mo–0.2Si (IMI 679); Ti–11Sn–2.25Al–4Mo–0.2Si (IMI 680); Ti–6Al–5Zr–1W–0.3Si (IMI 684); and Ti–6Al–5Zr–4Mo–1Cu–0.2Si (IMI 700). Beta processing is discussed under the headings forging, rolling, and heat treatment. The results showed that, while β forging and rolling can ease processing problems, provide closer tolerances, and shorter fabrication cycles, they can also profoundly affect the properties of some alloys. If fracture toughness is of importance β processing can provide the highest levels. However, it may be necessary to limit the tensile strength to 70 to 75 tons/in.^{2} (157 to 168 ksi) in order to achieve this. In a well-worked component β processing should not lead to significant reduction in fatigue life. β heat treatment appears necessary for the attainment of maximum creep resistance at highest temperatures, but such treatment is applicable only to weakly β stabilized alloys. (P.C.H.)

18325 AIR CONTAMINATION AND EMBRITTLEMENT OF TITANIUM ALLOYS. Shamblen, C. E.; Redden, T. K. (General Electric Co., Cincinnati). pp 199-208 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The relationship of oxygen concentration to hardness was experimentally determined and the diffusion of oxygen (air contamination) in the predominantly alpha allotropic structure of Ti–6Al–2Sn–4Zr–2Mo was approximated by microhardness traverses. The best expression of the air contamination diffusion coefficient below 1600°F was: $D_T = D_0 e^{-48{,}400/RT}$, where $D_0 = 147\ [O_2(ppM)]^{-0.742}$. However, a simplified approximation of the diffusion coefficient D_T can be determined by assuming $D_0 \approx 0.62$. A comparison of the air contamination rate data below 1500°F for unalloyed titanium (Ti–55A) and the alloys Ti–5Al–2.5Sn, Ti–8Al–1Mo–1V, and Ti–2.2Al–11Sn–5Zr–1Mo–2.5Si, (Ti–679) and Ti–6Al–2Sn–4Zr–2Mo confirmed the previous observation that depth of contamination is in general not as deep after a given exposure for the materials with lower substitutional alloying content. The titanium alloys evaluated to date only varied by a factor of two in depth of contamination for a given time-temperature exposure. The short-time air contamination rate data was found to be accurate for prediction of depth of contamination after exposures as long as 12,000 hr in the 700 to 900°F temperature range. Data correlation demonstrated that increasing depths of air contamination will increase the degree of embrittlement of titanium alloys as measured by degradation of tensile test reduction of area. However, the degree of embrittlement for a given depth of contamination is not equivalent for all alloys. Variations in the degree of embrittlement for the three alloys is suggested to arise from differences in toughness and metallurgical stability. (auth)

18326 PHYSICAL PROPERTIES OF TITANIUM ALLOYS. Collings, E. W.; Ho, J. C. (Battelle Memorial Inst., Columbus, Ohio). pp 331-47 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Physical properties and structural phase stability are discussed for two representative titanium alloy systems: the hcp (α) Ti–Al system, and the bcc (β) Ti–Mo system. Of interest in both systems is the variation of electronic Fermi state density $n(E_F)$ with alloying; and in the case of Ti–Mo, the influence of α–β transformation on $n(E_F)$. Extensive measurements of low temperature electronic specific heat coefficient γ and magnetic susceptibility χ have been made on these systems, simultaneous variations of γ and χ being accepted as indicating variations of $n(E_F)$ with alloy-

ing. For disordered (α) Ti–Al, $n(E_F)$ varies only slightly with aluminum concentration up to 15 at. %. But for the ordered intermetallic compound Ti_3Al, $n(E_F)$ is some 50% lower than the value obtained by extrapolation from the disordered region. In Ti–Mo, on the other hand, $n(E_F)$ varies with molybdenum concentration in a manner characteristic of binary transition-metal alloys of appropriate electron-to-atom ratios. (auth)

18327 CALCULATION OF REGULAR SOLUTION PHASE DIAGRAMS FOR TITANIUM-BASE BINARY SYSTEMS. Kaufman, Larry; Bernstein, Harold (ManLabs, Inc., Cambridge, Mass.). pp 361-72 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Previously developed computer techniques for calculating phase equilibria between regular solution phases and line compound-regular solution equilibria have been employed to compute binary phase diagrams for twenty titanium base systems including most of the transition metals and aluminum. Comparison with experimentally observed diagrams yielded satisfactory agreement. The description includes the activity of each component as well as the heat of formation of compound phases. Extension of this method to ternary and higher order systems should offer substantial advantages in application and development of advanced alloys and composite materials. (auth)

18328 INTERACTION OF TITANIUM WITH ELEMENTS OF THE PERIODIC SYSTEM. Kornilov, I. I. (Inst. of Metallury, Moscow). pp 407-18 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The reactions of elements in the periodic table with Ti are discussed on the basis of four chief divisions. These are: elements that form continuous solid solutions with the α- or β-modifications of Ti (Zr, Hf, V, Nb, Ta, and Mo); elements that form only limited solutions with α- and β-Ti with some intermetallic and covalent compounds (Mn, Re, Fe, Al, Sn, B, C, N, O_2 and others); elements that do not form solid solutions with α- and β-Ti, but form different kinds of compounds with covalent and ionic types of chemical bonds (F, Cl, Br, I, S, Se, Te, and Po); and the last group of elements, which do not interact with Ti and form neither solid solutions nor compounds (alkali and alkaline earth metals excluding Be). From the general classifications of Ti interaction with other elements, the types of phase diagrams in binary Ti systems are given and phase equilibria are discussed. (P.C.H.)

18329 DEFORMATION-ASSISTED NUCLEATION OF TITANIUM HYDRIDE IN AN ALPHA–BETA TITANIUM ALLOY. Boyd, J. D. (Battelle Memorial Inst., Columbus, Ohio). pp 545-55 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The characteristics of the nucleation of titanium hydride in Ti–8% Al–1% Mo–1% V have been investigated. Strip specimens were thermally charged with various amounts of hydrogen, and examined by transmission electron microscopy. Because there is an appreciable nucleation barrier, a total hydrogen content of 800 ppM is required before hydrides nucleate spontaneously. However, once the hydrides nucleate they grow rapidly and deplete the matrix of hydrogen. At lower hydrogen contents hydride nucleation can be assisted by small amounts of plastic strain. Specimens charged to at least 200 ppM hydrogen, and then deformed 2 to 3% at room temperature contain thin hydrides (80 to 100 Å thick), in the active {1010} slip planes. The results suggest that strain-induced hydrides form during the deformation of an alloy susceptible to low-strain-rate embrittlement, and also during the propagation of a stress-corrosion crack in aqueous environments. However, it is not known if the hydrides are the cause of either of these embrittling phenomena. (auth)

18330 HYDROGEN EMBRITTLEMENT OF TITANIUM AND ITS ALLOYS. Livanov, V. A.; Kolachev, B. A.; Buhanova, A. A. (Moscow Inst. of Aircraft Tech.). pp 561-76 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Under certain conditions of deformation and hydrogen contents above critical concentration, titanium and its alloys are affected by hydrogen embrittlement. Against the general opinion even β-titanium alloys at subnormal temperatures show the tendency to hydrogen embrittlement at relatively small concentrations of hydrogen. Conditions of deformation and the character of interaction of hydrogen with alloys bring to life different kinds of hydrogen embrittlement. A new classification of the kinds of hydrogen embrittlement according to their origin is proposed. The nature of the kinds of hydrogen embrittlement observed in titanium and its alloys is discussed in detail. (auth)

18331 PHASE TRANSFORMATIONS DURING WELDING AND THE MECHANISM OF DELAYED CRACKING OF TITANIUM ALLOYS. Shorshorov, M. Kh.; Meshcheryakov, V. N. (Inst. of Metallurgy, Moscow). pp 583-96 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Discussion is presented on phase transformations in the heat-affected zone during welding of Ti alloys, delayed failure and cold cracking when welding Ti alloys, and mechanical-thermal treatment of Ti alloys and its welded joints. Some of the Ti alloys discussed include Ti–Al–Zr, Ti–Al–V, and Ti–Cr–Al–Mo. It was established that the resistance of Ti to cold cracking on welding decreases with increase in the H, N, and O contents. Hydrogen has the most harmful effect, because the hydride conversion is connected with it, and this involves change of volume. Examination of the effects of the quenching temperature on the mechanical properties of the parent metal and welded joints after aging showed that the variation in strength and ductility depends to a large extent on the relation between the contents of several α and β stabilizers in the parent metal. (P.C.H.)

18332 TRANSFORMATION PLASTICITY OF TITANIUM. Kot, R.; Krause, G.; Weiss, V. (Syracuse Univ., N. Y.). pp 597-605 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The effects of concurrent temperature cycling through the phase transformation on the deformation characteristics of commercially pure titanium in tension and torsion and Ti–6Al–4V in tension have been studied. A considerable increase in the creep rate was observed due to the phase transformation. For commercially pure titanium proportionality between transformation strain and applied stress was observed up to 500 psi in tension and torsion. It was also found from the torsion data that the heating and cooling components of the transformation strain per cycle were equal. For Ti–6Al–4V the transformation strain and applied stress were proportional up to 400 psi in tension. The slope of the transformation strain vs stress curve, $\delta\epsilon/\delta\sigma$, was in agreement with the theoretical predictions of Greenwood and Johnson (Proc. Roy. Soc., A: 283, 403(1965)). Static room temperature tension tests performed on Ti–6Al–4V after repeated temperature cycling through the phase transformation under stress, exhibited a decrease in Young's modulus, strength, and ductility, while those of commercially pure Ti showed a much smaller effect. A die-less wire drawing method utilizing transformation plasticity is described. (auth)

18333 HOT PLASTICITY OF Ti–6Al–4V. Grant, Nicholas J.; Ioup, William; Kane, Robert H. (Massachusetts Inst. of Tech., Cambridge). pp 607-13 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The hot plasticity, as elongation at fracture, of both cast and wrought Ti–6Al–4V alloy was determined over the temperature interval 800 to 1065°C for strain rates of 10^{-4} to 10^{-1} sec. The alloy is of the α–β structure at 800 and 900° and of the β structure above about 1000°C. Ductility increased generally with decreasing strain rate for both the cast and wrought materials and for both the single-phase and two-phase structures. Grain size was indicated to be an important factor in determining ductility. Maximum ductility values somewhat greater than 200% were measured at 900 and 1010°C. On average the all beta structure (at 1010°C) was less creep resistant and more ductile than the $\alpha + \beta$ structure (at 900°C). A case is made for hot working in the β-field. (auth)

18334 SUPERPLASTICITY IN TITANIUM. Jovane, F. (Univ., Naples). pp 615-23 of Science, Technology, and Applica-

tion of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Preliminary work carried out to assess the possibility of pressure bulging a thin sheet of a Ti alloy, while in the superplastic condition, is reported. Following an approximate theoretical analysis proposed previously by F. Jovane (Int. J. of Mech. Sciences; 10: 403(1968) and AIME Congress, Cleveland (USA), Oct. 1967), which enables the strain rate during the deformation process to be kept within the superplastic range, thin circular discs of commercial Ti–6Al–4V were bulged to different heights at 950°C. The results obtained seem to show that the pressure-forming process is possible, but great care is required. Also, temperature and strain rate should be controlled. (P.C.H.)

18335 SOME ASPECTS OF PHASE TRANSFORMATIONS IN TITANIUM ALLOYS. Blackburn, M. J. (Boeing Scientific Research Labs., Seattle). pp 633–43 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The structural, crystallographic, and morphological characteristics of phase transformations in Ti alloys are reviewed. The three areas discussed include martensitic transformations, decomposition of metastable β phases, and ordering of the α-phase for binary Ti alloys with Al, Mo, Mn, Cr, Fe, and V. (P.C.H.)

18336 MARTENSITIC TRANSFORMATIONS IN TITANIUM ALLOYS. Hammond, C.; Kelly, P. M. (Univ. of Leeds, Eng.). pp 659–76 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The crystallography of the $\{344\}_\beta$ type martensite in Ti–15% Mo and Ti–5% Mn was evaluated. The crystallography of the $\{344\}_\beta$ martensites is explained on the basis that the $\{1011\}_\alpha$ twins constitute the inhomogeneous shear of the transformation and the experimental results were consistent with the predictions of the Bowles and Mackenzie (B.-M.) theory (J. W. Christian, The Theory of Transformations in Metals and Alloys, Pergamon Press, 1965). The results also suggest that both Class A ($\alpha - \omega$+) and Class A ($\alpha + \omega$+) solutions are to be expected in pure Ti. In the absence of the twin orientation these can only be distinguished by the differences between small deviations from the exact Burgers relationship. The crystallography of the fcc martensites is based on the assumption that the observed twins constitute the inhomogeneous shear of the transformation process. The crystallography of the singly and doubly twinned plates is explained on the basis that the $\{111\}_f$ twins constitute the inhomogeneous shear of the transformation process. (P.C.H.)

18337 EFFECT OF COOLING RATE ON THE BETA TRANSFORMATION IN TITANIUM–NIOBIUM AND TITANIUM–ALUMINIUM ALLOYS. Jepson, K. S.; Brown, A. R. G.; Gray, J. A. (Royal Aircraft Establishment, Farnborough, Eng.). pp 677–90 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

For titanium–niobium and titanium–aluminum alloys the cooling rate, at which there was a change from nucleation and growth to a shear transformation, decreased with increasing addition of alloying element and, in the case of titanium–niobium alloys, at least, this change was diffusion dependent. The change to a shear transformation was accompanied by a drop in the transformation temperature, which increased in magnitude with increasing alloy content. M_s varied with cooling rate; complete suppression of the shear transformation can be achieved in titanium–niobium alloys. In both alloy systems the martensitic transformation appeared to be thermally activated. Kaufman's method for calculating T_θ yielded results that are incompatible with the measurements of M_s and β_s in the titanium–niobium system but were compatible with the data obtained for titanium–aluminum alloys. (auth)

18338 THERMODYNAMICS OF THE M_s POINTS IN TITANIUM ALLOYS. Huang, Y. C. (Tokai Univ., Hirazuka, Japan); Suzuki, S.; Kaneko, H.; Sato, T. pp 691–3 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

A general thermodynamic treatment of M_s and β_s points of Ti alloys is given along with the driving force for initiation of the bcc ⇌ cph martensitic transformation. The M_s point of Ti as a function of alloying additions was plotted, and it showed that the decrease produced in M_s temperature by additions differs greatly for the various elements. However, elements soluble in the β solid solution, whose interatomic distances are larger than that of Ti, lower the M_s point considerably. No difference was found between $T_{\theta\ exp}$ and $T_{\theta\ calc}$ (temperature at which the energies of two phases are equal) curves for the system Ti–Zr, and the same results were obtained for the systems Ti–Mo, Ti–V, and Ti–Nb. The required energy to initiate the $\beta-\alpha'$ and $\alpha'-\beta$ transformations at the bcc ⇌ cph martensitic transformation was found to be about −50 to −60 cal/mole, by plotting M_s and β_s points into the $\Delta F^{\beta-\alpha'}$ temperature. (P.C.H.)

18339 CONTINUOUS COOLING-TRANSFORMATION OF β-PHASE IN BINARY TITANIUM ALLOYS. Huang, Y. C. (Tokai Univ., Hirazuka, Japan); Suzuki, S.; Kaneko, H.; Sato, T. pp 695–8 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

An apparatus has been developed for thermal analysis of alloys during rapid and slow cooling, and based on the results of thermal analysis and structure identification, more than 85 Ti-base alloys in 16 binary systems have been investigated. The results showed that the effects of additions on the stability of the supercooled β-phase can be classified into two groups: elements that decrease the upper-critical-cooling-velocity are V, Cr, Mo, Nb, Pt, Co, An, and Zr; and elements that increase the upper-critical-cooling-velocity are Cu, Ag, Pb, Bi, Al, Fe, Mn, and Ni. The M_s points of alloys were also obtained from the CCT diagrams, and in most cases the M_s point decreased with increasing the additions in each system, except in the systems of Ag, Pt, Al, and Sn. (P.C.H.)

18340 MORPHOLOGY OF THE OMEGA PHASE. Hammond, C. (Univ. of Leeds, Eng.). pp 711–18 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The ω-phase of Ti-base alloys was evaluated using electron microscope methods, and this was related to one of two possible structures. A Ti–5% Mn alloy was studied in which the β-phase partially transforms to ω on quenching. The results suggest that the cubic structure is the correct one. The observation that the ω-phase in the quenched alloy has a slightly larger lattice parameter than the retained β-phase (i.e., is solute poor) suggests that the transformation is not diffusionless. The ω-phase has a morphology markedly similar to that of the γ' (Ni_3Al–ordered fcc) phase which occurs in Ni-base (Nimonic) alloys. The shape of the γ' precipitate changes from perfect spheres to perfect cubes as the particle size, and more importantly the lattice misfit with the matrix increases. This appears to be the case with the ω-phase; in the quenched alloy where the misfit is ~0.2% it forms as spheres and these grow into cubes on aging as the lattice misfit increases. (P.C.H.)

18341 STABILITY OF THE OMEGA PHASE IN TITANIUM AND ZIRCONIUM ALLOYS. Vanderpuye, N. A.; Miodownik, A. P. (Univ. of Surrey, Eng.). pp 719–29 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The available characteristics of the pressure-induced omega transformation in pure titanium and zirconium, and the behavior of omega in alloy systems, are combined to give an interpretation of omega formation in terms of a peritectoid reaction. This allows the omega-phase to be derived from the properties of the parent lattice, but also yields a specific region of stability which may coincide with a characteristic electron-concentration. The critical temperature associated with the peritectoid reaction offers an explanation for the upper temperature limit observed for the omega phase on heating metastable beta alloys. A thermodynamic analysis of the relative positions of the α, β, ω transus lines and the corresponding αM_s and ω start curves shows that it is the αM_s which largely dictates the onset of ω formation on cooling. Hence the composition of the hardness peak on quenching is largely controlled by the limited solubility of solute in the α-phase. A full delineation of the peritectoid in titanium alloys is not possible owing to insufficient experimental data. However, the region of omega stability at 400°C was determined by analyzing plateau hardness values and lattice parameters of quenched and tempered alloys of varying solute content. The proportion of ω in tempered β reflects the maximum solute solubility in these two phases. Neither electron-concentration nor size considerations can properly account for the full extent of omega stability, which encompasses the pure solvent under suitable conditions of temperature and pressure. (auth)

18342 MARTENSITIC TRANSFORMATION IN TITANIUM BINARY ALLOYS AND ITS EFFECT ON MECHANICAL PROPERTIES. James, D. W. (Central Electricity Generating Board, Leatherhead, Eng.); Moon, D. M. pp 767-78 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The effects of the martensitic transformation on the mechanical properties of three titanium binary alloys (Ti–8% Mo, Ti–12% V, Ti–17% Nb) were investigated. At quenching temperatures close to the $\beta/(\alpha+\beta)$-phase boundary an abrupt transition in mechanical properties occurs. As the quenching temperature was decreased through a range of 10°C, the elastic modulus, hardness, and tensile strength increased markedly and the internal friction decreased by a factor of up to 100. The preceding data have been correlated with observations derived from light microscopy, electron microscopy (replica and transmission), and x-ray diffraction work. Above the transition the microstructure consisted of a mixture of β and martensite. As the quenching temperature was lowered into the transition region, equilibrium α began to form thereby increasing the concentration of β-stabilizing elements (V, Mo, and Nb) in the β-phase. As a result, only a small amount of β decomposed martensitically. Below the transition temperature ω formed in the stabilized β-phase. A model is proposed which explains the transition in mechanical properties in terms of a stress-induced martensitic transformation. (auth)

18343 USING OF THE JOMINY TEST TO COMPARE THE QUENCH HARDENABILITIES OF TITANIUM ALLOYS Ti–6Al–4V AND Ti–6Al–6V–2Sn. Moulin, J. (Pechiney Group Research Center, Voreppe, France); Molinier, R.; Syre, R. pp 779-82 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

In comparison with the Ti–6Al–4V (T-A6V) alloy from which it is derived, Ti–6Al–6V–2Sn (T-A6V6E2) exhibits a higher strength level in the annealed and in the aged conditions; in addition its quench hardenability can be expected to be better. The hardness variations with distance from the quenched end of the Jominy bars in T-A6V and T-A6V6E2 alloys were determined after solution anneal at 860°C. Hardness distributions in the Jominy bars in the quenched condition and after aging are related on end-quench hardenability curves, which are given. The maximum of the hardness vs distance curve which corresponds to the formation of the ω-phase is closer from the quenched surface for the T-A6V alloy than for the T-A6V6E2 alloy; this shows a better stability of the β-phase for the second alloy. Better quench hardenability of the T-A6V6E2 alloy was definitely established. (P.C.H.)

18344 THERMO-MECHANICAL STRENGTHENING OF HIGH STRENGTH TITANIUM ALLOYS. Margolin, H.; Farrar, P. A.; Greenfield, M. A. (New York Univ., N. Y.). pp 795-808 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies that suggest how the ductility of high yield strength $\alpha-\beta$ Ti alloys can be controlled are reported. It was shown that the spread between yield and fracture stress determines reduction of area. For a constant heat treatment the fracture strength has been found to be a function of the size, morphology, and location of the alpha and size of beta grains. Additionally, the fracture strength must be a function of the deformation and fracture behavior of both alpha and the aged beta matrix. Equations relating fracture strength to microstructure have been derived for two alpha configurations, equiaxed, and Widmanstaetten plus continuous alpha. In a tension test fracture begins by void formation at alpha–beta interfaces. The lower tensile ductility of Widmanstaetten and continuous alpha structures below a $D^{-\frac{1}{2}}$ of 6.5 at approximately constant yield stress has been ascribed to the lower fracture stress of this structure. The lower fracture stress, it is proposed, results from easier link up of voids to form a propagating crack and a greater percentage of voids which would aid crack propagation. An explanation for the higher toughness of Widmanstaetten and continuous alpha structure based on the lower yield and fracture stress of the alpha–beta interface is offered. Implications for processing of alpha–beta alloys are discussed. (auth)

18345 THEORETICAL BASES OF THE DEVELOPMENT OF THE HIGH-STRENGTH METASTABLE β-ALLOYS OF TITANIUM. Ageev, N. V.; Petrova, L. A. (Inst. of Metallurgy, Moscow). pp 809-14 of Science, Technology, and Application of Titanium. Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Systematic investigations and established regularities for the rational choice of developing high-strength metastable β alloys of Ti are discussed. Criteria for the choice of elements for β–Ti alloys are listed. Taking into consideration these criteria, the β-alloying elements, for their total effectiveness, can be arranged in the order Fe, Cr, Mn, V, Mo, Co, Ni, Nb, Re, Ta, and W. Aluminium, to inhibit the undesirable ω-phase, should be introduced into the alloy, but not more than 3%. (P.C.H.)

18346 STRENGTHENING MECHANISMS DURING THE HEAT TREATMENT OF THREE TITANIUM ALLOYS: Ti–6Al–4V, Ti–6Al–6V–2Sn, AND Ti–8Al–1V–1Mo. Fopiano, P. J.; Hickey, C. F. Jr. (Army Materials and Mechanics Research Center, Watertown, Mass.). pp 815-16 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The strengthening mechanisms of three commercial alloys were compared. The results of hardness measurements, resistance measurements at the aging temperature, x-ray, and electron microscope observations are discussed. Specimens of all alloys were mostly solution treated in the $\alpha+\beta$ region where the β phase was either retained or transformed during the quench from the solution temperature. The effects of solution treatment on the relative proportions and compositions of the phases present and the subsequent effects of these variables on the aging responses were also considered. A sluggishness of the 8Al–1V–1Mo alloy as opposed to 6 Al–6V–2Sn (and 6Al–4V) was brought out by an investigation of the change in resistance as a function of time at the aging temperature. These results confirmed the development of a second phase which is diffusion controlled (presumably Al in Ti) and to the secondary hardening occurring for longer aging times. Based on differences in the response time and the constancy of the activation energy of some 35 kcal/g at. for the three alloys, it was concluded that it is the frequency factor in the general diffusion equation that controls the sluggishness of the aging response in the 8–1–1 alloy compared to the other alloys. Specifically, it is postulated that the increasing V content in going from 8–1–1 to 6–6–2 contributes to an increased frequency term in a manner completely analogous to the effect of impurity additions on the self diffusion of Ag. (P.C.H.)

18347 STRENGTHENING OF TITANIUM ALLOYS BY SHOCK DEFORMATION. Koul, M. K.; Breedis, J. F. (Massachusetts Inst. of Tech., Cambridge). pp 817-28 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The strengthening of titanium and titanium–molybdenum alloys by shock deformation at pressures of 70 and 200 kilobars has been investigated and the mechanical properties correlated with the terminal microstructures. Four initial structures, hexagonal close-packed α-phase, α'-martensite, metastable body-centered cubic β-phase, and stable β-phase, were included in the study. Unalloyed titanium exhibited the greatest percentage increase in strength while the stable β-phase alloy exhibited the least. The highest tensile strength was attained with the metastable β-phase alloy shock-deformed at 70 kilobars. High densities of dislocations and twins were introduced by deformation in all alloys, while the hexagonal close-packed alloys underwent phase transformation between 70 and 200 kilobars pressure. Greatest strengthening was obtained after simultaneous deformation and transformation during shock deformation. (auth)

18348 LONG-TIME STABILITY OF Ti-679 AFTER CREEP EXPOSURE FOR TIMES TO 15,000 HOURS. Erdeman, V. J.; Ross, E. W. pp 829-37 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Long-time creep exposure at 750 to 900°F and the resultant stability of Ti-679 were studied on specimens taken from 4-in.-thick forgings. The stability was determined by measuring the retained room temperature tensile ductility of the exposed creep specimens which had been strained to 0.13 to 0.44% plastic creep. After 15,000 hours at 800°F and 60 ksi, the room temperature tensile reduction of area was reduced to 12% from the original of 30 to 35% for unexposed material. A similar loss in ductility was observed after 6000 to 7000 hours at 850°F/44 ksi. Tests were also conducted at 750, 900, 950, and 1000°F. Optical and electron microscopy and x-ray and electron diffraction were utilized to determine the cause for the ductility losses. The factors that influenced stability were: surface absorption of O_2, beta decomposition and agglomeration, and precipitation of silicon. (auth)

18349 EFFECT OF ELEVATED TEMPERATURE EXPOSURE ON THE ROOM TEMPERATURE PROPERTIES OF TITANIUM ALLOYS 8Al–1Mo–1V, 6Al–4V, AND 4Al–2Mo–1V. Turbitt, Bruce; Geisendorfer, Robert (Boeing Co., Seattle). pp 839–41 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Machined specimens of each alloy were subjected to experimental time-temperature cycles to determine the effects of thermal exposure at temperatures of interest in such processes as diffusion bonding, hot sizing or forming, and heat treatment. Exposure temperatures were incrementally chosen between 1300 and 1900°F (705 to 1040°C) while times were selected from 0.2 to 20 hrs. The effects of variations in the heating and cooling rates on the properties were also studied. The results are presented in graphical form by alloy and material condition for mechanical properties data, and in chart form by alloy and initial condition for the composite microstructures. Of the two primary variables evaluated, time and temperature, temperature produced the treatest unit change with respect to both mechanical properties and microstructure. Mill annealed Ti–8Al–1Mo–1V exhibited the most change in mechanical properties after exposure followed by 4Al–3Mo–1V and 6Al–4V in order of decreasing effect. In general, increased exposure time and temperature caused the ultimate and yield strength to decrease while elongation and impact toughness increased. The property least affected by time-temperature exposure was hardness. (P.C.H.)

18350 TITANIUM ALLOYING IN THEORY AND PRACTICE. Rosenberg, H. W. (Titanium Metals Corp. of America, Henderson, Nev.). pp 851–9 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The Ti–Al–Sn–Zr system was surveyed with emphasis on 1000°F creep strength and retention of ductility (stability) after creep exposure. Stability is assured if $\%Al + \frac{1}{3} \times \%Sn + \frac{1}{6} \times \%Zr + 10 \times \%O \lesssim 9$. Ti–6Al–2Sn–2Zr was found to be the creep/density optimized stable alloy. The alloying behavior of Ti was consistent with a metallic bonding valence of four and an alloy structure valence of 1.5. Covalent bonding between Ti and Al was confirmed. This substantially precludes blocking Al embrittlement through dilution of alpha soluble additions of elements from groups IV_B, V_B and VI_B. Ti–6Al–2Sn–4Zr–2Mo was found to have good hot strength and creep resistance. Between about 850 and 1050°F, Ti–6Al–2Sn–4Zr–2Mo obeys a creep rate equation of the general form $\dot{\epsilon} = A \exp [-(H' - B\sigma^*/RT)]$ for small strains and strain rates. (auth)

18351 EFFECT OF THE GROUP III ELEMENTS Al, Ga, AND In ON THE CREEP AND STRESS RUPTURE OF TITANIUM AT 500°C. Jepson, K. S.; Larke, L.; Stubbington, C. A. (Royal Aircraft Establishment, Farnborough, Eng.). pp 861–73 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies were made on the effects of Al, Ga, and In on the mechanical properties of Ti, the 100-h rupture stress at 500°C being chosen as the principal comparison. Binary alloys containing 5 at. % Al, Ga, and In and 10 at. % Al and ternary alloys containing 8 at. % Al–2 at. % In, 8 at. % Al–3 at. % In, 8 at. % Al–2 at. % Ga, and 8 at. % Al–3 at. % Ga were made and tested. The results on creep data and the estimated 100 h rupture stresses indicated that on an atomic percentage basis Ga is a more effective strengthener than Al or In. The increased ability to resist creep deformation was clearly related to the improved work hardening when gallium was present as illustrated by the absence of local necking. It was concluded that Ga is clearly a more effective alloying element than Al in strengthening Ti, and Ga-containing alloys of comparable properties to those currently commercially available could, presumably, be developed with a lower atomic percentage of alloying element and therefore a reduced capability of giving the troubles attendant on the presence of Ti_3Al ordering. (P.C.H.)

18352 STRUCTURE AND CREEP PROPERTIES OF Ti_7NbAl_3 BASE ALLOYS. Prinzbach, F.; Winter, H. (Battelle Institut eV, Frankfurt am Main). pp 875–8 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies were made on the Ti–Al–Nb system, especially the quasibinary Ti–$NbAl_3$ section and the Ti_7NbAl_3 phase of the system. The effects of certain factors on the properties of this phase were also considered. X-ray analysis showed that the phase Ti_7NbAl_3 has a hexagonal structure with the lattice parameters $a = 5.81$, $c = 9.40$, and $c/a = 1.61$. Tensile tests at 800°C furnished values up to 57 kg/mm² for the Ti_7NbAl_3-base alloy. The oxidation resistance of the alloys also was quite satisfactory. The weight gain for the alloys in the quasibinary section had a minimum near the composition of the base alloy Ti–15.5Al–18Nb. After exposure to still air at 800°C during 100 hr the average increase in weight was about 0.42 mg/cm². Alloys of the composition Ti_7NbAl_3, especially with small additions of Si and Hf, had very interesting properties at elevated temperatures; they showed an exceptionally favorable combination of high creep strength, high oxidation resistance, and low density; the density was almost the same as that of pure Ti; alloys of this kind can be forged and rolled in air at temperatures around 1200°C. (P.C.H.)

18353 INFLUENCE OF MICROSTRUCTURE ON THE MECHANICAL PROPERTIES OF FORGED ALPHA/BETA TITANIUM ALLOYS. Ashton, S. J.; Chambers, L. H. (High Duty Alloys, Ltd., Slough, Eng.). pp 879–89 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The relation between the mechanical properties of selected forged alpha/beta titanium alloys and the various microstructures produced by heating, with or without further working, in the alpha/beta and beta regions has been investigated in a three-part program. The initial work, concerned with thermal treatments only, showed that for IMI.314A all-Widmanstaetten structures produced by cooling from the all-beta region gave the best creep resistance and the highest room temperature tensile strength with satisfactory impact and fatigue resistance, although the ductility was decreased. These behavior patterns are also applicable to IMI.318A. The next stage which involves the assessment of beta-forged IMI.679 compressor blades and flat discs concluded that although the forgeability is increased, the properties are such as to be generally unacceptable to British aero gas-turbine-engine designers. In the last section, the minimum amounts of original alpha in the microstructure and the corresponding maximum preheating temperatures, which gave acceptable properties in IMI.679 and Hylite 50, were deduced. The establishment of this type of information for existing and new titanium alloys will be valuable in determining the correct forging conditions. (auth)

18354 INFLUENCE OF CARBON AND OXYGEN ON SOME EXPLORATORY ULTRA-HIGH STRENGTH ALPHA–BETA TITANIUM ALLOYS. Ayvazian, Arthur; Colton, Robert (Army Materials and Mechanics Research Center, Watertown, Mass.). pp 897–9 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Existing information on the behavior of O and C in the presence of certain substitutional elements in Ti was supplemented by studies on the effects of varying the concentration of these interstitials on the mechanical properties of a series of high-strength Ti alloys. The alloys, based on the Ti–6Al–6V–2Sn alloy, were alloyed with varying amounts of Zr, Cu, Fe, Cr, Mo, Ni, Si, and B. The results indicated the difficulty in attempting to classify similar high-strength Ti alloys by an interstitial level. Even though specific trends or characteristic behaviors did not appear for the groups of alloys evaluated at the different interstitial levels, it was illustrated that by using certain combinations of C plus O added to the less complex alloys, mechanical properties could be obtained in the 190,000 to 215,000 yield strength range, which were comparable to those realized with the more highly alloyed compositions containing beta substitutional elements such as Mo and Cr. (P.C.H.)

18355 WELDABILITY, TENSILE, AND FATIGUE PROPERTIES OF SOME TITANIUM ALLOYS. Scott, M. H.; Dinsdale, W. O. (Welding Inst., Abington, Eng.). pp 911–22 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies on the weldability of Ti sheet alloys showed that TIG welds could be made in all the eight titanium sheet alloys considered without difficulty. The tensile properties of welds in α alloys compared well with those of the parent sheet although the ductility decreased with increased alloying content. This trend was more noticeable in $\alpha\beta$ alloys where the ductility of the weld metal was sometimes low enough to cause concern. The β

alloys had poor weldability as it was impossible to obtain an acceptable combination of strength and ductility. Of the alloys whose fatigue properties were examined, alloy C (Ti–2Cu) behaved very well, the welds being as strong as the parent sheet. Alloys L (Ti–8Al–1Mo–1V) and A (Ti–6Al–4V) had reasonable fatigue strengths but the behavior of both was unusual, particularly A which showed a most curious crack pattern. (auth)

18356 FATIGUE PROPERTIES OF A HIGH STRENGTH TITANIUM ALLOYS (IMI.680). Jukes, R. A. (Lucas Gas Turbine Equipment Ltd., Birmingham, Eng.). pp 923-31 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Both untreated and plain notched samples of IMI.680 (Ti–Sn–Mo–Al–Si) were fatigue tested, and an assessment of the effects of surface finish on the basic properties was included. All coating techniques reduced the fatigue strength of the IMI.680 alloy below the control value of ±41 tonf/in^2 for 10^7 cycles. With the exception of the plasma-spray tungsten carbide coating, the reduction was to a level below the notched value of ±19 tonf/in^2 for a notch value of K_t 3.3. The plasma spray tungsten carbide coated IMI.680 gave an endurance limit of ±29 tonf/in^2 for rotating bending, and ±28 tonf/in^2 for direct stress. The grit-blasting operation applied prior to plasma-spray coating reduced the fatigue properties of the base alloy. A thickness of up to 0.005 in. of tungsten carbide may be plasma sprayed onto a grit-blasted titanium alloy surface without further effect on the fatigue properties. Increasing the thickness of coating above this value resulted in a further fall in the fatigue properties of the base alloy possibly because of the increasing residual stress value in the coating. (auth)

18357 ELASTICITY OF TITANIUM SHEET ALLOYS. Zarkades, A.; Larson, F. R. (Army Materials and Mechanics Research Center, Watertown, Mass.). pp 933-41 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Results from a program in which strain gage measurements were made of the elastic properties on various sheet titanium alloys are reported. Methods for computing polycrystalline elastic properties from single crystal values were reviewed and these calculated curves were then compared to the actual test results. It was observed that the anisotropic variations in elastic properties of titanium and its alloys depend upon two factors. The first is the basic elastic anisotropic characteristics of the titanium single crystal, and the second is the intense preferred orientations commonly found in the wrought products. It was also established that moderately accurate predictions of elastic anisotropy can be made for polycrystalline aggregates with elementary textures and that the constant stress model is adequate for describing the behavior patterns found in titanium sheet material. (auth)

18358 ROLE OF DEPTH HARDENABILITY IN THE SELECTION OF HIGH STRENGTH ALLOYS FOR AIRCRAFT APPLICATIONS. Duncan, R. M.; Minton, C. D. T. (Imperial Metal Industries, Ltd., Birmingham, Eng.). pp 945-57 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The reasons for variations in depth hardenability of Ti alloys are discussed, and these are related to the IMI Ti 680 (Ti–11Sn–2¼ Al–4Mo–0.2Si) and Ti 700 (Ti–6Al–5Zr–4Mo–1Cu–0.2Si) alloys. Also, the mechanical properties of Ti alloys with tensile strength greater than 70 tonf/in.^{2} (157 ksi) are reviewed on the basis of the section thicknesses in which specification strength levels are attainable, and typical properties of components. The results showed that for good hardenability and a minimum strength of 70 tonf/in.^{2} (157 ksi) it is necessary to have either a metastable beta alloy or an alpha + beta alloy with a complex alpha base alloyed with a strong beta stabilizer. Of the Ti alloys currently available for structural applications Ti–13V–11Cr–3Al and Ti 680 appear to be the most attractive where high strength is required through very thick sections, but Ti–13V–11Cr–3Al exhibits low ductility. The alloys Hylite 50 and Ti 700 (4% Mo) offer the best combination of specific strength and depth hardenability in the strength ranges considered. (P.C.H.)

18359 METALLURGICAL CHARACTERISTICS AND STRUCTURAL PROPERTIES OF Ti–8Mo–8V–2Fe–3Al SHEET, PLATE, AND FORGINGS. Hunter, D. B. (Titanium Metals Corp. of America, Henderson, Nev.); Arnold, S. V. pp 959-68 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

The development and properties of Ti–8Mo–8V–2Fe–3Al, which is an ageable beta titanium alloy, are described. Ti–8Mo–8V–2Fe–3Al is a metastable beta alloy which is readily produceable as plate, sheet or forgings. In the solutionized condition it is easily fabricable. It has very deep hardenability and rapid aging response to high strength levels. It is amenable to a variety of treatments which result in a corresponding number of useful property combinations. (auth)

18360 HIGH STRENGTH TITANIUM ALLOYS FOR AIRCRAFT GAS TURBINE APPLICATION. Doyle, J. R.; Ruckle, D. L.; Sprague, R. A. (United Aircraft Corp., Hartford, Conn.). pp 969-78 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies were made on the critical properties of available Ti alloys with specific strength/density levels of 1.05 to 1.20 × 10^6 in. (i.e., yield strength levels of 170 to 190 ksi) for fan blade applications at temperatures up to 400°F. Ti–6Al–6V–2Sn (ELI), Ti–6Al–6V–2Sn–1Cu–1Fe–3Zr, and Ti–6Al–6V–2Sn–1Cu–1Fe–3Zr–0.1C alloys were found to be readily forgeable into component geometries and have a uniform and predictable response to heat treatment. Although tensile properties exceeded those of typical Ti–6Al–4V by as much as 45%, the notched combined stress fatigue properties of Ti–6Al–4V and the Ti–6Al–6V–2Sn alloy systems were only comparable. The achievement of 5 to 10% elongation in combination with high reductions in area (25 to 40%) does not imply high fracture energy absorption. Fracture energy absorption properties were a better indicator than tensile properties of high and low cycle fatigue behavior. The basic Ti–6Al–6V–2Sn (ELI) alloy had the best property balance for a high strength fan blade application. (auth)

18361 STUDY OF THE METALLURGICAL CHARACTERISTICS OF Ti–6Al–6V–2Sn ALLOY. Molinier, R. (Trefimetaux GP, Argenteuil, France); Moulin, J.; Syre, R. pp 979-82 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

A metallurgical study and full-scale development were conducted on the T-A6V6E2 alloy (Ti–6Al–6V–2Sn). The effects of heat treatments on mechanical properties are discussed, and the results were interpreted through optical and electron microscopy examinations as well as x-ray diffraction experiments. The β transus of the alloy was found to be 945 ± 10°C by vacuum dilatometric measurements. It was noted that the strength increased and the ductility decreased as the solution annealing temperature was raised. It appeared that the governing factor in the development of the tensile properties of the alloy was the β-phase transformation. On a practical basis, the following treatment gives a quite good combination of strength and ductility: solution annealing at 875°C water quench and aging at 580°C for 4 h. (P.C.H.)

18362 DEVELOPMENT OF A SUPERIOR TITANIUM-BASE ALLOY FOR CRYOGENIC APPLICATIONS. Kropp, C. J.; Hurlich, A. (General Dynamics Corp., San Diego, Calif.). pp 983-5 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Because the room temperature yield strength of the 5Al–2.5Sn–Ti ELI (extra low impurity) alloy may be as low as 95,000 psi, a program was undertaken to develop a superior Ti alloy for cryogenic temperature applications; the goal being an alloy having a minimum yield strength of 120,000 psi and low temperature toughness at least as good as that of the 5Al–2.5Sn–Ti (ELI) grade. Following several eliminations based on ingot hardness, metallography, and tensile and notched (K = 6.3) tensile tests at 75 and −423°F. The alloy 6Al–4V–Ti (ELI) was found to be superior to 5Al–2.5Sn–Ti (ELI) alloy. (P.C.H.)

18363 EXPLOITATION OF A SIMPLE ALPHA TITANIUM ALLOY BASE IN THE DEVELOPMENT OF ALLOYS OF DIVERSE MECHANICAL PROPERTIES. Fentiman, W. P. (Imperial Metal Industires Ltd., Birmingham, Eng.); Goosey, R. E.; Hubbard, R. T. J.; Smith, M. D. pp 987-99 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Experience initiated by a requirement for a Ti alloy with useful

creep strength at 400°C or higher is reviewed. From a study of highly alloyed simple alpha bases a composition was selected, further alloyed, and heat treated not only to fulfil the original development target but also to provide other Ti alloys offering different combinations of strength and temperature capability. Typical tensile and creep properties of three alloys illustrating the combinations of strength and temperature capability that were achieved by selective further alloying and controlled heat treatment of a simple Ti–11Sn–2.25Al alpha alloy base are given. The alloys consist of the addition of 5Zr, 5Zr–1Mo–0.2Si, or 4Mo–0.2Si to Ti–11Sn–2.25Al. (P.C.H.)

18364 CREEP-RESISTANT TITANIUM ALLOYS. Seagle, S. R.; Bomberger, H. B. (Reactive Metals, Inc., Niles, Ohio). pp 1001-8 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Titanium alloys developed recently in an attempt to meet new, but somewhat elusive goals for use in modern jet engines are discussed. Several Ti alloys appear to have properties suitable for high-temperature creep-resistant applications. These include the silicon-containing alloys RMI 5621S, Hylite 65, IMI 684, and 6242 + Si, and also 6242. Comparative tensile data for these alloys at room temperature and 900°F are given. (P.C.H.)

18365 FATIGUE CHARACTERISTICS OF TITANIUM ALLOY FORGINGS FOR ROTARY WING VEHICLES. Tiktinsky, M. (Lockheed-California Co., Burbank). pp 1013-21 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Unique applications for titanium alloy forgings in rotary wing airplanes are indicated and advantage is taken of the high tensile and fatigue strength–weight ratios, good weldability, and excellent corrosion resistance of titanium. These advantages have been demonstrated by qualification fatigue tests of the forgings produced in this program, primarily Ti–6Al–4V and Ti–6Al–6V–2Sn. (auth)

18366 PRODUCTION AND PROPERTIES OF SOME WEAR-RESISTANT COATINGS ON TITANIUM–4 PERCENT MOLYBDENUM–4 PERCENT ALUMINUM–2 PERCENT TIN ALLOY (HYLITE 50). Bowers, J. E.; Finch, N. J.; Burberry, M. G. (British Non-Ferrous Metals Research Associations, London). pp 1081-96 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Wear and fatigue properties have been determined for the Ti–4% Mo–4% Al–2% Sn–½% Si alloy, Hylite 50, commercially coated with molybdenum by metal spraying or oxidized in a molten borate bath at 800 to 950°C (1472 to 1742°F), and for hard chromium coatings electrodeposited in the laboratory. The best results were obtained with hard chromium coatings deposited on starting coatings of silver and nickel suitably heat treated. (auth)

18367 MARINE APPLICATIONS OF TITANIUM. Williams, W. Lee (Naval Ship Research and Development Center, Annapolis). pp 1153-60 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Marine applications of Ti are predicated in large measure by two considerations; those applications in which Ti is the only practical material capable of meeting required performance characteristics; and those in which superior performance characteristics provide the best cost effectiveness during equipment life. Several applications in which certain characteristics influence the choice of Ti are described. Two general categories are covered: first, machinery and hardware; and second, primary structures. Some of the alloys discussed include: Ti–6Al–4V, Ti–6Al–6V–2Sn, Ti–6Al–2Nb–1Ta–0.8Mo, and Ti–Al–Mo. (P.C.H.)

18368 TITANIUM APPLICATIONS: U. S. ARMY. Kinas, E. N. (Army Materials and Mechanics Research Center, Watertown, Mass.). pp 1161-7 of Science, Technology, and Application of Titanium. /Jaffee, R. I. (ed.). Oxford; Pergamon Press Ltd. (1970).

From Science, technology, and application of titanium conference; London, England (21 May 1968).

Studies either made or funded by the U. S. Army on unalloyed Ti and Ti alloys for use in military applications are discussed. The importance of testing and evaluating end products in demonstrating the effects of impurities was stressed, i.e., unpredicted failures of Ti aircraft engine components in production were attributed to the presence of excessive H and very expensive corrective measures were required by a commercial facility. The U. S. Army was fortunate in uncovering deficiencies in toughness in several components and end items during the product development stage. The initial emphasis on Ti applications for the Army centered on armor for armored vehicles. Some of the alloys used by the Army include Ti–6Al–4V, Ti–6Al–6V–2Sn, and Ti–13V–11Cr–3Al. A study is being conducted to develop modified compositions of Ti–6Al–6V–2Sn possessing yield strengths in excess of 200,000 psi with acceptable ductility and toughness. (P.C.H.)

18369 INVESTIGATION OF THE POSSIBILITY OF SUBSTITUTING TANTALUM–NIOBIUM ALLOY FOIL FOR THE TANTALUM FOIL USED IN MAKING DRY ELECTROLYTIC CAPACITORS. Zhikharev, Yu. V.; Kovalev, K. S.; Novikova, S. M.; Romanova, N. A.; Chuprikov, A. V. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 66-70(1971). (In Russian).

The possibility of substituting tantalum–niobium alloys for tantalum in making capacitor foil is considered. An investigation is made of the effect the niobium content in tantalum has on the special electrical properties of capacitor foil. The heat treatment temperature effects on the properties of foil made from tantalum–niobium alloys are described. The permissible concentration of niobium in tantalum which has no adverse affect on the special characteristics of capacitor foil is given. The potential field of application of foil made from niobium–tantalum alloys in capacitors of various ratings is indicated. The basic electric characteristics are given for dry capacitors of various ratings made from tantalum–niobium alloy foil. (JPRS)

18370 ROLE OF CRYSTAL STRUCTURE IN THE FRICTION AND SEIZING OF METALS. Nosovskii, I. G.; Isaev, E. V.; Kostetskii, B. I. Dokl. Akad. Nauk SSSR; 198: No. 1, 79-82 (1 May 1971). (In Russian).

The part played by the crystal structure in determining the friction characteristics of metals and their tendency towards seizing is discussed in the light of experiments carried out on Co and La which pass from the hcp to the fcc type of lattice at 420 and 220°C, respectively. The results show that seizing is mainly controlled by volume interaction, diffusion, and the transfer of mass between the contiguous surfaces undergoing friction. The intensity of seizing is determined by the mechanism of plastic deformation and the number of defects formed during the process, which in turn depend on the crystal structure. (Metals Abstr.)

18371 ELECTRON MICROSCOPE STUDY ON EARLY STAGES OF AGING IN Cu AND Ni BASE BINARY ALLOYS CONTAINING Be. Kainuma, Toshio; Watanabe, Ryoji (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 35: No. 12, 1126-33(Dec 1971). (In Japanese).

The changes in microstructure during the initial stages of aging in Cu–1.8 wt% Be and Ni–2.5 wt% Be alloys were systematically examined by means of electron transmission microscopy and electron diffraction. It was found that during the formation and growth of Guinier–Preston (G.P.) zones in these two alloys there were some significant changes in details of the diffraction patterns obtained. In the earliest stage of the G.P. zone formation, the short streaks were observed in a complex manner at each of the normal diffraction spots. In the subsequent stage, the long streaks appeared along ⟨100⟩ directions, which were typical of a plate-like G.P. zone. Furthermore, the extra spots were observed at the positions of ordering reflections. In the later stage, the intensity maxima were observed on the ⟨100⟩ long streaks. The short streaks were thought to arise from the elastic strain effects induced by the formation of the G.P. zones on {100} planes. The complex morphology of the short streaks observed was found to be given by the geometrical relation between the short streaks of the reciprocal lattice point and Ewald's sphere of reflection. It was also found that the appearance of the extra spots was not due to an ordered structure but due to the intersection of the long ⟨100⟩ streaks with the reflecting sphere. (auth)

18372 LANTHANONS AS NUCLEAR CONTROL MATERIALS. Ray, W. E. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Eng. Des.; 17: No. 3, 377-96(1971).

Lanthanons have been used by the nuclear industry not only in pure metallic form but also as alloys, ceramics, and dispersions of ceramic particles in metallic matrices. Most applications in both research and power reactors have arisen because of the unusual effectiveness of the lanthanons as resonance absorbers of neutrons in the 0.001 to 1000 eV range. The performances of materials containing lanthanons are reviewed with regard to chemical and metallurgical stability, irradiation damage resistance, retention of nuclear worth, and resistance to deterioration of mechanical properties. The techniques applied in extracting

lanthanons from their ores, preparing lanthanon compounds, reducing compounds to pure metals, alloying, and preparing dispersions are presented. Fabrication methods used to produce a variety of neutron-absorbing components for research and power reactors are briefly reviewed. (auth)

18373 EFFECT OF DEGREE OF EXHAUSTION AND COMPOSITION OF RESIDUAL GASES IN WORKING CHAMBER ON VAPOUR PRESSURE OF METALS AND ALLOYS. Fedorov, G. B.; Kalinin, P. I.; Smirnov, E. A.; Ivanov, K. V. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 683-5(May 1971). Translated from Zh. Fiz. Khim.; 45: No. 5, 1218-19(May 1971).

An integral form of the Knudsen effusion method has been used to measure the vapor pressures of silver and β-zirconium using respectively the radioactive silver-110 isotope over the range 840 to 960°C and the radioactive zirconium-95 isotope over the range 1000 to 1650°C. Measurements were made in a grease-free vacuum obtained by means of electric discharge pumps—with a residual vacuum of 10^{-8} mmHg for silver and at a pressure of 10^{-8} mmHg or more for zirconium. (auth)

18374 THERMODYNAMIC PROPERTIES OF LIQUID Zn–Cd SOLUTIONS. ESTIMATION OF THE ERROR IN ACTIVITY CAUSED BY SIDE REACTIONS. Moser, Z. (Inst. for Metal Research, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 19: No. 9, 669-78(1971).

By the emf method of concentration cells with the liquid electrolyte and electrodes, the thermodynamic properties of the Zn–Cd liquid solutions at the temperatures 714 to 877°K and the concentration ranges of zinc $X_{Zn} = 0.1$ to 0.9 were worked out. For the interpretation of the experimental results Krupkowski's formulas were used. These formulas made it possible to find the partial and molar thermodynamic functions which were compared on the diagrams with the data from literature. A good agreement was found. Next the analysis of error in activity on the basis of Wagner and Werner's method was performed, which justified the procedure of obtaining the linear emf formulas only for temperatures up to 805°K. The linear equations, emf vs temperature, obtained in this manner made possible the calculation of the emf data for the whole temperature range 714 to 877°K and a wide thermodynamic analysis of the liquid Zn–Cd solutions. (auth)

18375 EFFECT OF CARBON ON THE OCCURRENCE OF Cu_3Au-TYPE PHASES IN ACTINIDE– AND LANTHANIDE–PLATINUM METAL SYSTEMS. Holleck, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 42: No. 3, 278-84 (Mar 1972).

Actinide and lanthanide metals with a trivalent state in the solid form Cu_3Au-type compounds with palladium according to MPd_3 (M = Sc, Y, lanthanides, Np, Pu, Am); metals with a tetravalent or pentavalent state form Cu_3Au-type phases with rhodium according to MRh_3 (M = Ce, Th, U, Pu) or with palladium according to MPd_4 (M = Ce, Th, U, Pu). This latter composition probably corresponds to the formula $M_{0.75}Pd_3$ as proved in the case of uranium. Uranium with a hexavalent state is the only metal forming a Cu_3Au-type compound with ruthenium according to MRu_3 (M = U). Investigations in ternary carbon containing systems should clarify the influence of carbon in interstitial positions of the Cu_3Au-structure. The experimental results showed that the trivalent metals form carbon stabilized ordered phases with rhodium according to MRh_3C_{1-x} ($0 \leq x \leq 0.3$) (M = Y, lanthanides) and that the tetra- or pentavalent metals form carbon stabilized compounds with ruthenium according to MRu_3C_{1-x} ($0 \leq x \leq 0.3$) (M = Ce, Th, U). Compounds of the metals with different valence states (Ce, U, Pu) showed homogeneity regions with respect to the metal/metal ratio and the carbon content. In the compounds considered the interstitial carbon was surrounded by an octahedra of rhodium or ruthenium atoms, respectively. The influence of carbon in these octahedral interstitial positions on the stability of the metal lattice can be interpreted with an increase of the effective valency of the platinum metals. Preparation techniques and lattice parameters for 16 new perovskite-carbides of the rare earth metals with ruthenium and rhodium are given. (auth)

18376 INFLUENCE OF THE MATRIX ON THE HYDROGEN EMBRITTLEMENT OF ZIRCONIUM IN BEND TESTS. Hardie, D. (Univ. of Newcastle-upon-Tyne, Eng.). J. Nucl. Mater.; 42: No. 3, 317-24(Mar 1972).

Slow-bend testing of various samples of zirconium and Zircaloy-2, hydrided to different levels up to 1000 ppM, revealed a transition temperature below which unstable crack propagation occurs. This temperature was raised by increasing the hydrogen content up to about 300 ppM and then became effectively constant. The hydride distribution was dependent on prior strain but did not have a very pronounced effect on fracture transition. The latter was much more dependent on the plastic properties of the matrix and the 0.7% flow stress of vacuum-annealed material provided a useful guide to the temperature of transition. Energy stored owing to plastic straining of the matrix around brittle hydride may, or may not, be sufficient to induce crack propagation from one hydride to the next when precipitates are fractured at about 0.7% plastic strain. (auth)

18377 CRYSTALLOGRAPHIC STUDY OF THE ALLOTROPIC TRANSFORMATION $\beta \rightarrow \alpha$ IN ZIRCONIUM SLIGHTLY ALLOYED WITH PLUTONIUM. Cornet, J.-F. (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater.; 42: No. 3, 325-38(Mar 1972). (In French).

Zirconium alloys with a low plutonium content (0.3 to 3 wt%) after holding in the bcc β phase-field and slow-cooling exhibited signs of segregation, i.e., zones depleted in plutonium. Crystallographic examination showed that the orientation relationships characteristic of the $\beta \rightarrow \alpha$ martensitic transformation in zirconium were not affected by the presence of the solute. The segregated zones were in the form of needles, the long axes of which were parallel to one of the $\langle 111 \rangle$ axes of the high-temperature cubic structure. This conclusion was confirmed by the fact that no more than four distinct directions of needles within the confines of any one former β grain are ever encountered. (auth)

18378 ELECTROPLATED COATINGS: SELECTION FACTORS. Spencer, Lester F. Metal Finish.; 69: No. 9, 64-9(Sep 1971).

Zinc, Cd, and Sn were compared as corrosion-resistant coatings for protecting ferrous parts. Suggested standards for quality Zn and Cd coatings on Fe and steel were tabulated for degrees of exposure from mild to very severe. Characteristics of protective-decorative coatings of Cu–Ni–Cr and Ni–Cr on steel, Fe, and Zn products were then compared and tabulated. Brass, bronze, Au, Ag, and black Ni deposits are discussed more briefly. (Metals Abstr.)

Radiation Effects

Refer also to abstracts 18112, 18121, 18472, 19712, 19731, and 19854.

18379 (ORNL-TM-3629) RADIATION DAMAGE TO REFRACTORY METALS AS RELATED TO THERMIONIC APPLICATIONS. Wiffen, F. W. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 29p. (CONF-711038-2). Dep. NTIS.

From IEEE thermionics conversion specialist conference; San Diego, Calif. (4 Oct 1971).

The effects of fast neutron irradiation on the body-centered cubic refractory metals were reviewed with emphasis on materials and conditions typical of thermionic applications in space power systems. Changes produced in the microstructure were characterized as a function of irradiation temperature. The effects of fluence, alloying, and purity were examined where data were available. Swelling and changes in the mechanical and electrical properties produced by neutron irradiation were briefly reviewed. The major effects expected were in the collector and cooler portions of the emitter in a thermionic diode where swelling, electrical resistivity increases, and ductility losses were anticipated during reactor operation. (auth)

18380 (SCL-DC-710338) FLASH X-RADIOGRAPHY OF A BLOWOFF PLUME. Dean, D. K.; Henry, K. W. (Sandia Labs., Albuquerque, N. Mex.). Dec 1971. Contract AT(29-1)-789. 19p. (CONF-711208-7). Dep. NTIS.

From Underground nuclear test measurements symposium; Albuquerque, N. Mex. (7 Dec 1971).

The mass density as a function of distance from the surface of an aluminum sample subjected to electron beam irradiation has been measured. A flash radiographic technique utilizing a high speed rotating film disc camera was employed to radiograph the material ejected following pulsed energy deposition in the sample at a maximum level of about 1000 cal/gram. The radiographic data were reduced by numerical processing which scaled the data in terms of equivalent absorption thickness of aluminum by comparison with an aluminum step-wedge image. The result is compared with predictions made using WONDY and with a framing camera picture of a prior but comparable experiment. Although preliminary, this result demonstrates the applicability of this technique to the general problem. (auth)

18381 (SCL-DC-720202) KERR CELL PHOTOGRAPHY OF THE BLOWOFF PLUME. Dean, D. K.; Van Dyke, D. P. (Sandia Labs., Albuquerque, N. Mex.). Dec 1971. Contract AT(29-1)-789. 17p. (CONF-711208-8). Dep. NTIS.

From Underground nuclear test measurements symposium, Albuquerque, N. Mex. (7 Dec 1971).

An experiment is reported in which a series of Kerr cell photographs of molten blowoff from aluminum samples was taken at 5, 16, 75, 95, and 160 microseconds after irradiation by a 700-keV electron beam. The results are compared with previous test results obtained with a high speed framing camera. The physical structure of the molten and solid material in the blowoff ejecta appears to be related to the size of the grains in the original solid material. (auth)

18382 (TID-6249) RADIATION TESTING OF SHIELD SPECIMEN: TEST LTH_x-4. Lee, R. C. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept. Oak Ridge National Lab., Tenn.). 6 Jan 1958. 50p. (DC-58-1-55). Dep. NTIS.

A lithium hydride specimen was irradiated for 740 hours at 400°F to a dose of $\sim 2.1 \times 10^{19}$ nvt. The capsule was disassembled and the LiH sample shipped for analysis. (auth)

18383 (TID-6250) RADIATION TESTING OF SHIELD SPECIMEN: TEST LTH_x-5 AND 6. Reagan, M. P. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept. Oak Ridge National Lab., Tenn.). 16 Jan 1958. 30p. (DC-58-1-211). Dep. NTIS.

Tests LTH_x-5 & 6 containing specimens of lithium hydride in separate capsules were combined into one test and irradiated in Hole C-48 of the LITR at ORNL. Specimen "A" was run at 600°F and specimen "B" was run at ~160°F for 583.0 hours. Results from preliminary examinations are included. (auth)

18384 (UJV-2621-M) CORRELATION BETWEEN THE RATE OF RADIATION GROWTH OF POLYCRYSTALLINE ALPHA-URANIUM WITH SMALL PREFERRED ORIENTATION AND THE GROWTH INDEX G2. Novak, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1971. 12p. (In Czech). INIS.

Radioinduced swelling in polycrystalline alpha-uranium with small preferred orientation was studied using the theory of macroscopic creep of orthotropic media. The deformation of each grain was supposed to equal the deformation of the polycrystal. The growth index of samples in a near-isotropic state was found not to determine unambiguously the rate of polycrystal deformation even when the parameters characterizing plastic properties of single grains and the rate of the radioinduced swelling of the monocrystal in the direction (010) had been constant. (INIS)

18385 ANNEALING EFFECTS ON THE BORDONI PEAK AND THE ELASTIC MODULUS ANOMALY IN 99.999 PERCENT PURE Au AFTER WORK HARDENING AND IRRADIATION WITH FAST NEUTRONS. Gradchamp, P. A.; Bays, B.; Benoit, W. (Univ., Lausanne, Switzerland). Mem. Sci. Rev. Met.; 68: No. 9, 617-27(Sep 1971). (In French). (CONF-700941-7).

From Meeting on metallurgy; Paris, France (28 Sep 1970).

The recovery of the Bordoni peak and the elastic modulus anomaly after work hardening at room temperature and liquid nitrogen temperature and also after irradiation with fast neutrons at low temperature was studied. The changes in the measured values of both characteristics enabled the pinning of dislocations by point defects to be demonstrated. The recovery energies associated with the 2nd and 4th stages were measured: 0.4 eV and 0.83 eV respectively. (France)

18386 EFFECT OF NEUTRON IRRADIATION ON THE GRAIN BOUNDARY INTERNAL FRICTION PEAK. Bose, S. K.; Mishra, R.; Bhattacharya, D. L. (Banaras Hindu Univ., India). Acta Met.; 20: No. 3, 469-71(Mar 1972).

Observations on the grain boundary internal friction peak in polycrystalline aluminum after neutron irradiation at low doses are reported. On neutron irradiation the grain boundary peak has been depressed and shifted to lower temperature side. This effect can be explained in terms of rotation of interstitials in the dumb-bell configuration and their trapping by impurity atoms. On annealing, these impurity atoms segregate near the grain boundary region which depresses the peak. (auth)

18387 EFFECT OF NEUTRON IRRADIATION ON SECOND-PHASE PRECIPITATION PROCESSES. Ostrovskii, Z. E.; Chernyaev, G. A.; Grintchuk, P. P.; Votinov, S. N.; Prokhorov, V. I. (Scientific-Research Inst. of Atomic Reactors, Melekess, USSR). Trans. Iron Steel Inst. Jap.; 11: No. 5, 289-93(Sep 1971).

The effects of neutron irradiation on OX16H15M3G austenitic stainless steel aging were investigated by electron microscopy. It was found that after irradiation up to 1.9×10^{20} n/cm^2 ($E \geq 1$ MeV) at 680 to 700°C the acceleration of the excessive phase precipitation processes took place. The results of the work as well as the data previously obtained for radiation effects on some stainless steels aging were interpreted with the scheme of the excessive phase temperature range displacement to lower temperatures under irradiation. The displacement scheme suggested was confirmed by the results of structure investigations on a series of other aging alloys (e.g. on Al-Si-Mg alloy after irradiation at 50 to 60°C and 110 to 130°C). (Japan)

Other Materials

Refer also to abstracts 17469, 17532, 17541, 18144, 18410, and 19854.

18388 (AECL-3689) SPECIFIC HEAT AND ENTHALPY OF LIQUID HEAVY WATER. Rosta, P. Z. (Atomic Energy of Canada Ltd., Sheridan Park (Ontario)). May 1971. 69p. (TDAI-43). Dep. NTIS (U. S. Sales Only). AECL $1.50.

A thorough literature survey was carried out for enthalpy and specific heat measurements on liquid D_2O. On the basis of the findings, isobaric specific heat and relative specific enthalpy tables were prepared for the saturated and compressed liquid D_2O in the ranges 0.1 to 21 MN/m^2 absolute pressure and from room temperature to about 640°K. (31 references). (auth)

18389 (AED-CONF-71-100-36) BEHAVIOUR OF ANISOTROPIC AND ISOTROPIC GRAPHITES UNDER REACTOR CONDITIONS IN A CO_2 GAS LOOP ON THE BR-2 MOL WITH DIFFERENT ADDITIONS OF CO, CH_4, H_2O, AND H_2 AS INHIBITORS. Muellerthann, M. (Deutsche Babcock und Wilcox A.G., Oberhausen (West Germany)). May 1971. 36p. (CONF-710901-530). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A loop was added to the BR-2 reactor to investigate the radioinduced graphite corrosion in CO_2 at gas pressures of $\gtrsim$50 atm abs and radiation intensities (>8 W/gC) with additions of inhibitors, such as CH_4, CO, H_2O and H_2. Results of 10 experiments in which 4 to 6 different graphites were exposed simultaneously to irradiation with a relatively constant gas composition are presented. (J.R.D.)

18390 (BNL-50255) PRELIMINARY SURVEY OF POLYMER-IMPREGNATED STONE. Steinberg, Meyer; Colombo, Peter (Brookhaven National Lab., Upton, N. Y.). Sep 1970. 55p. Dep. NTIS.

A preliminary survey was performed to investigate the impregnation of a relatively weak porous Oregon volcanic tuff and a relatively strong dense sandstone with five different monomers: methyl methacrylate, chlorostyrene, 40% TMPTMA-60% styrene, 40% TMPTMA-60% chlorostyrene, and 60% polyester-40% styrene. Impregnation was performed by pressurizing stone specimens from one end and by a vacuum-soak operation. In situ polymerization was accomplished by both radiation and chemical initiation techniques. The effect of varying degrees of water saturation on the impregnation and properties of the polymer-impregnated stone was determined. The compressive strength of dry porous volcanic tuff can be increased by factors of at least 2 to as much as 5 over that of the unimpregnated control, depending on the monomer used and the weight loading. A maximum compressive strength value of 19,740 psi compared with a control value of 4,390 psi was obtained for dried tuff stone impregnated with 23.6 wt % loading of 60% polyester-40% styrene by the vacuum-soak technique and in situ polymerization by radiation. For the more dense sandstone a maximum value of 28,780 psi, compared with a control value of 13,980 psi, was obtained for a 3.8 wt % loading of chlorostyrene and polymerized by radiation. Radiation gave slightly better strength values than chemical initiation. The modulus of elasticity increased by factors of 2 to 3.5. Pressurization from one end gave lower weight loadings; however, strength increases were still higher by a factor of 5 than those for unimpregnated controls. Water saturation of the stone strongly reduced the ability of the monomer to impregnate the stone and displace the water. Water contents at 25% of maximum saturation markedly reduced the compressive strength of polymer-impregnated stone. Saturation beyond 25 and up to 100% had little further effect on the strength of polymer-impregnated stone. The 60% polyester-40% styrene gave a maximum improvement in strength of a factor of 2 for 25% to 100% water-saturated tuff stone. Further tests on other types of mine-type stone, including shale and coal should be performed. Design studies evaluating the improvement in stone strength after polymer impregnation for application to mine wall stabilization are recommended. (auth)

18391 (JUL-798-RW) INVESTIGATION OF THE SYNTHESIS OF ISOTROPIC PYROCARBON COATINGS ON COATED PARTICLES BY MEANS OF ULTRASONICS. Suetterlin, L.; Buesch, H.; Luhleich, H.; Nickel, H.; Hoven, H. (Kernforschungsanlage,

Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Sep 1971. 55p. (In German). Dep. NTIS (U. S. Sales Only).

Development and improvement of the coating of nuclear fuel particles require a detailed knowledge of the characteristics of pyrocarbon. It is known that current technology used as a basis for describing pyrocarbon for coating of particles, especially the high density isotropic (HDI) layer, is insufficient. Therefore, it is necessary to find additional characteristics for the description of the HDI layer. The behavior of coated particles under high energy loading using ultrasonic equipment was investigated. It was found that different patterns of HDI layers reveal different light intensity reductions. A qualitative correlation exists between the optical extinction and the structure of the HDI layer. A distinctive shell structure of the HDI layer reveals a low optical extinction. (J.R.D.)

18392 (RDT-M-12-3-T(10-71)) MINERAL FIBER HYDRAULIC-SETTING THERMAL INSULATING AND FINISHING CEMENT (ASTM C449 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1971. 4p. RSO.

A standard prescribing requirements for mineral fiber hydraulic-setting thermal insulating and finishing cement (ASTM C 449 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

18393 (SC-RR-710920) USE OF RF ACTIVATED GAS TREATMENT TO IMPROVE BONDABILITY. DeLollis, N. J. (Sandia Labs., Albuquerque, N. Mex.). Jan 1972. 16p. Dep. NTIS.

Various theories of adhesion and the modification of some of the recent proposals as a result of recent work in the field are reviewed. The use of rf activated oxygen to improve adhesion to RTV silicone is described. Examination of the surfaces by IR transmission shows the presence of possible weak boundary layer both before and after treatment. Radio frequency activated argon is used to treat RTV silicone and polyethylene to improve adhesion. Critical surface tension on both materials is increased significantly. Treatment with ultraviolet emission from rf plasma produces essentially the same results. The contradictions of these findings with recent theory are also discussed. (auth)

18394 (TID-25826) AN EXAMINATION OF THE FRACTURE BEHAVIOR OF GRAPHITE THROUGH THE USE OF SPLITTING TENSILE TESTS. Yahr, G. T.; Valachovic, R. S.; Greenstreet, W. L. (Oak Ridge National Lab., Tenn.). [1971]. 24p. Dep. NTIS.

Comparisons of results from tests conducted on splitting tensile specimens made from AXM and ATJ graphites with analytical predictions indicated that linear-elastic fracture mechanics methods can be used for predicting fracture of graphite under complex stress states. Circular and elliptical disks were tested under lateral, collinear, compressive loads, the forces being applied along a diameter of the circular disks and along the major axis of the elliptical disks. Elliptical disks with major-to-minor axis ratios (α/β) of 1.5 and 2.0 were used. Predictions of failure loads were obtained through the use of finite element analysis methods in combination with linear-elastic fracture mechanics methods. (auth)

18395 USE OF THE RICHTER PROGRAMS FOR CALCULATING GRAPHITE CORROSION IN HELIUM COOLED HTRs. Hawtin, P. (Atomic Energy Research Establishment, Harwell, Eng.); Huber, R. A.; Kyte, W. S.; Wilmore, D. J. Brit. Nucl. Energy Soc.; 11: No. 1, 81-9(Jan 1972).

The use of a mathematical model of graphite corrosion by water vapor to solve problems arising in the design of helium-cooled high-temperature reactors is described. The treatment of bulk flow and the gas shift reaction is discussed, together with typical boundary conditions. It is shown that many time-dependent problems are sufficiently slow to be treated by an adiabatic approximation where a series of slowly changing steady states are set up. Numerical results are given for a hypothetical case to show the importance of the gas shift reaction and the change in permeability caused by the graphite corrosion. (auth)

18396 NUCLEAR RADIATION ABSORBING GLASS. Bromer, Heinz; Meinert, Norbert; Preuss, Hans-Jorgen (to Ernst Leitz GmbH). U. S. Patent 3,619,219. 9 Nov 1971. Priority date 29 Aug 1968, Germany.

A glass having improved neutron absorption properties for use as viewing windows in nuclear facilities is described. The glass was made by adding WO_3 to LiO_2/BeO/Bo_3-glass. In this type glass the Be and Li serve as neutron moderators, while the B acts as a neutron absorber after the neutrons have been slowed down to the thermal region. The addition of WO_3 increases the solubility of Li_2O in the boric acid former, thereby producing a glass with better neutron moderating properties. More importantly, the W is capable of capturing neutrons having energies in the epithermal region. By adding W it is safely possible to reduce the thickness of the protective shield up to one-third. The effects of the W can even be increased if other elements which are capable of capturing epithermal neutrons are added to the glass, e.g., Sm. The addition of Sm and W has the advantage that the fields of high absorption ranges superimpose and complement each other in the epithermal region. (T.F.D.)

18397 IMPLICATIONS OF THE BEHAVIOR OF ADVANCED COMPOSITE MATERIALS. Ashton, J. E. J. Franklin Inst.; 290: No. 6, 549-66(Dec 1970).

The behavior of advanced composite materials, e.g., B/epoxy resin, is discussed in relation to the analysis and design of composite structures. The anisotropy of these materials, stress-concentration effects, fatigue strength, time-dependent strain-rate effects, and fracture toughness are considered. The extent of investigations on these composite materials is outlined. (Metals Abstr.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstracts 17388, 17852, and 18417.

18398 (KFK–1100) JOINT INTEGRAL SAFEGUARDS EXPERIMENT (JEX 70) AT THE EUROCHEMIC REPROCESSING PLANT, MOL, BELGIUM, JANUARY 1970–JULY 1971. Kraemer, R.; Beyrich, W. (eds.) (European Atomic Energy Community. Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Aug 1971. 504p. (EUR–4576). Dep. NTIS (U. S. Sales Only). EUR F.Fr. 66.–.

The details are presented of the methods used and the results obtained in an integral safeguards experiment carried out in the EUROCHEMIC reprocessing plant as a joint undertaking in the framework of the association for safeguards: CEN, EURATOM, GfK, and with collaboration of other organizations (ACDA, AECB, IAEA, USAEC). The objectives of this safeguards exercise cover mainly problems associated with accountability of nuclear material in a reprocessing plant such as: identification techniques for spent fuel elements in the fuel storage pond using a special television camera device and equipment for measuring the gamma activity ratios of suitable fission products, verification of operators input data by means of isotope correlation techniques, and extended interlaboratory tests on present analytical methods for U and Pu concentrations and determinations of isotopic compositions in realistic feed, product, and waste flows. Special objective of this joint experiment was an experimental demonstration of a new physical inventory technique which correlates isotopic compositions of subsequent input and product batches. Detailed theoretical investigations using digital simulation models on U and Pu flow through the EUROCHEMIC plant were carried out in order to obtain quantitative statements on limiting conditions and accuracy of this new inventory technique. (auth)

18399 (KFK–1110) DEVELOPMENT OF SAFEGUARDS PROCEDURES AND SIMULATION OF FISSILE MATERIAL FLOW FOR AN ALKEM TYPE PLANT FABRICATING PLUTONIUM FUEL ELEMENTS FOR FAST BREEDER REACTORS. Drosselmeyer, E.; Gupta, D.; Hagen, A.; Kurz, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Aug 1971. 138p. Dep. NTIS (U. S. Sales Only).

Safeguards procedures for ALKEM-type plants fabricating fast breeder reactor fuels were developed. The plant layout was analyzed and the strategic areas relevant for safeguards control were established. Special emphasis was given to the study of instruments which can be used. One main consideration was that safeguards control should not hinder the normal operating procedures. A simulation program was developed which can give information on the process features and can be of help for the control. Also, a system of records and reports was designed. For the material balance, the variances of MUF were studied in order to give an estimate of the probability of detecting possible diversion. Improvements of instruments, methods, and plant layout which could facilitate safeguards control are suggested. (auth)

18400 (MLM–1798) CALORIMETRY FOR SAFEGUARDS PURPOSES. DETERMINATION OF PLUTONIUM IN REACTOR FEED MATERIAL. O'Hara, F. A.; Nutter, J. D.; Rodenburg, W. W.; Dinsmore, M. L. (Mound Lab., Miamisburg, Ohio). 5 Jan 1972. Contract AT-33-1-GEN-53. 44p. Dep. NTIS.

The purpose of this work is to test the feasibility and applicability of the calorimetric assay technique for safeguarding radioactive materials involved in the reactor fuel cycle, primarily plutonium. Included is a brief history of calorimetry, a description of the instrumentation and techniques used, and the results of the calorimetric assay of two reactor-fuel samples. These samples each contained approximately 1 kg of plutonium oxide feed material with isotopic compositions typical of plutonium from fast breeder reactors and light water reactors. (auth)

Disposal and Storage

Refer also to abstracts 17728, 17759–17761, and 17767.

18401 (AED-CONF–71-100-40) ACTUAL STATUS OF THE TREATMENT AND FINAL STORAGE OF RADIOACTIVE WASTES IN THE FEDERAL REPUBLIC OF GERMANY. Krause, H. (Kernforschungszentrum, Karlsruhe (West Germany)); Kuehn, K.; Levi, H. W.; Merz, E. May 1971. 23p. (CONF-710901–531). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The current status of the treatment and final storage of radioactive wastes in West Germany is reviewed. Information is included on: the treatment of low- and intermediate-level liquid wastes to produce solid residues which can be stored in the central national repository at the Asse salt mine; the incineration of combustible solid wastes; research at Karlsruhe on the solidification of high-level liquid wastes; treatment of high-level liquid wastes from fuel reprocessing at Juelich; basic research on glasses for high-level waste fixation; and the design and operation of facilities at the Asse salt mine repository. It is concluded that the methods developed for the storage of radioactive solid residues, the installations provided or under construction, and the existing space will allow the safe disposal of all waste arising in the Federal Republic of Germany throughout the coming decades. (L.C.L.)

18402 (EUR–4736) HEALTH IMPLICATIONS OF THE STORAGE OF RADIOACTIVE SUBSTANCES ON AND IN THE GROUND. Colloquium at Cherbourg-La Hague, France, April 14–15, 1970. Smeets, J.; Amavis, R. (eds.) (European Communities, Luxembourg. Commission). 122p. (In English and French). (CONF-700452). EUR DM 22,–.

Seven papers on the health implications of the storage of radioactive materials on and in the ground were presented at the conference. A separate abstract was prepared for each paper. (L.C.L.)

For abstracts of individual papers see: 17728, 17759–17761, and 18403–18405.

18403 (EUR–4736, pp 17-50) LONG-TERM FORECASTS OF THE PRODUCTION OF RADIOACTIVE WASTE IN THE EUROPEAN COMMUNITY. Grison, G. (European Communities, Luxembourg. Commission). 1970.

From Conference on health implications of the storage of radioactive substances on and in the ground; Cherbourg-La Hague, France (14 Apr 1970).

The current production of radioactive wastes in the European Community is discussed, and data are presented on predictions to 2000 AD on the annual production of low-, intermediate-, and high-level wastes for fuel reprocessing plants, nuclear research centers, power reactors, and research in industry and universities in the European Community. (L.C.L.)

18404 (EUR–4736, pp 53-75) INTERACTION BETWEEN THE ENVIRONMENT AND RADIOACTIVE SOLID WASTES DISPOSED OF ON OR IN THE GROUND. Branca, G. 1970.

From Conference on health implications of the storage of radioactive substances on and in the ground; Cherbourg-La Hague, France (14 Apr 1970).

The interaction between the environment and radioactive wastes disposed on or into the ground are discussed. The aspects considered include: the action of the environment on the contamination associated with the wastes; the action of the environment on the materials containing the wastes; and the dispersion in the environment, mainly by hydrologic transport, of radioisotopes originating from solid wastes stored underground. (L.C.L.)

18405 (EUR–4736, pp 89-100) CONSEQUENCES FOR HEALTH OF THE STORAGE OF RADIOACTIVE WASTE IN THE GROUND AND ASSESSMENT OF THE STORAGE CAPACITY OF A SITE. Mechali, D. 1970.

From Conference on health implications of the storage of radioactive substances on and in the ground; Cherbourg-La Hague, France (14 Apr 1970).

The public health hazard from surface- or underground-storage of radioactive wastes is associated with possible contamination of ground waters and their uses. The ways by which man can be affected by ground water contamination, the admissible limits of exposure of the public, and methods for determining the limits of activities which can be stored without exceeding dose limits to man are discussed. (L.C.L.)

18406 (ORNL–4726) THERMAL ANALYSIS OF THE NATIONAL RADIOACTIVE WASTE REPOSITORY: PROGRESS THROUGH JUNE 1971. Cheverton, R. D.; Turner, W. D. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 90p. Dep. NTIS.

Solidified high-level fuel reprocessing wastes and alpha-contaminated solid wastes are to be placed in salt formations 1000 ft below the earth's surface at the proposed National Radioactive Waste Repository near Lyons, Kansas. The heat released from these wastes will result in temperature increases throughout the

immediate geologic formations. The following several factors influence the permissible temperature rises: thermal instability of the solidified waste; migration of brine; integrity of the mine during operation; integrity of the overlying formations; temperature in freshwater aquifers; temperature of the earth's surface; and temperatures beyond the boundaries of the mine. Preliminary thermal calculations indicated the technical feasibility of the Repository. More recent analyses have considered the Repository in greater detail and have employed updated thermal property and stratigraphic data. The results from these analyses indicate that all of the criteria can be satisfied, and that a heat load of about 130 kW/acre is acceptable for 10-year-old high-level waste. (auth)

18407 (ORNL-4751) RADIOACTIVE WASTE REPOSITORY PROJECT; TECHNICAL STATUS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1971. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 320p. Dep. NTIS.

Progress in evaluating the Lyons, Kansas salt mine as a repository for solidified high-level wastes is reported. Information is included on: the geohydrological characteristics of the proposed site; the thermal and rock mechanics analyses which have been performed; description of the site and its facilities; characteristics of the solidified wastes; studies of the energy storage in the salt and solidified wastes under the transient thermal and radiation conditions which will prevail in the repository; the radiolytic and thermal reactions in salt brines near the waste containers; the ecological effects of the repository; and the significance of possible release of radioactive materials to the atmosphere. (L.C.L.)

18408 (ORNL-TM-3650) STORAGE, SHIPMENT, AND DISPOSAL OF SPENT FUEL CLADDING. Blomeke, J. O.; Perona, J. J. (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 22p. Dep. NTIS.

Several hundredths of a percent of the Pu in spent reactor fuels will be associated with the metal cladding, and this will probably necessitate the future storage of this waste material in a federal repository. A study of the design parameters for packaging, interim storage, shipment, and disposal of cladding in the proposed salt mine repository indicates that economics favor compacting the hulls as densely as possible, packaging them in 9-in.-dia cylindrical containers, and shipping them to the repository without interim storage at the reprocessing plant. The minimum total costs for their management in this fashion (excluding the cost of compaction) is estimated to be 0.004 mills/kWh (e) for LWR cladding and 0.009 mills/kWh (e) for LMFBR cladding. By the end of this century, 69,000 ft^3 of compacted cladding containing 3200 kg of plutonium will have accumulated. It is estimated that a total of 112 acres of salt mine area will be required for its burial. (auth)

18409 PRINCIPLES FOR LIMITING THE INTRODUCTION OF RADIOACTIVE WASTE INTO THE SEA. Slansky, C. M. (International Atomic Energy Agency, Vienna). At. Energy Rev.; 9: No. 4, 853-68(Dec 1971).

The basic principles concerning the marine disposal of radioactive wastes are discussed. It is shown how these principles can be applied in practice, and indicates the basic methodology for establishing procedures for limiting the releases of radioactive waste into the seas and oceans. The procedures are mainly scientific, but also involve economic and social aspects. The final decisions must be made by competent national authorities, taking into account both national and international guidelines. Attention is drawn to the now widely established principles of monitoring both waste and the environment, and suggests a need for both national and international records of waste discharges. Areas where further research is required are discussed. (auth)

18410 SOLIDIFICATION OF LOW- AND INTERMEDIATE-LEVEL WASTES. Burns, R. H. (Atomic Energy Research Establishment, Harwell, Eng.). At. Energy Rev.; 9: No. 3, 547-99(1971).

The present and proposed methods for solidification of low- and intermediate-level radioactive wastes in bitumens and cements are reviewed. (T.F.D.)

18411 DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTES AT A LARGE UNIVERSITY INCINERATOR. Wollan, Ralph O.; Staiger, Jerome W.; Boge, Raymond J. (Univ. of Minnesota, Minneapolis). Amer. Ind. Hyg. Ass. J.; 32: No. 9, 625-32(Sep 1971).

The University of Minnesota incinerator is used for disposal of low-level combustible radioactive waste. Calculations have been made to determine the concentration of radioactive material in the air and ash effluent. Air dilution volumes are determined by continuous airflow and temperature monitoring devices. It was demonstrated that such an incinerator can be used to dispose of low-level radioactive waste within prescribed limits. (auth)

Handling Equipment and Procedures

Refer also to abstracts 17682 and 18408.

18412 (CEA-N-1460) STUDY AND THE IMPLANTATION OF A COOLED ION GUN IN A HIGHLY ACTIVE CELL. Fremiot, Claude; Houdaille, Brigitte; Toutin, Michel; Vignesoult, Nicole (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1971. 22p. (In French). Dep. NTIS (U. S. Sales Only).

An ion gun designed to be used in conjunction with a shielded cell is described; it can be used to etch nuclear materials and has a flexibility of operation allowing it to be used for many purposes ranging from simple ionic cleaning to the deep etching required for electron microscopic observation with replicas. Results of etching irradiated nuclear fuels are presented. The results emphasize the advantages of using a cryostat to cool the sample. The improvements brought about by this new design have produced a very versatile instrument which has extended the applications of ion bombardment to a greater number of materials. (France)

18413 EQUIPMENT FOR TRANSFERRING SAMPLES OF IRRADIATED MATERIAL. Blaix, Noel; Lequeux, Germain; Zabe, Bernard (to Commissariat a l'Energie Atomique). French Patent 2,065,637. 6 Aug 1971. Filed 19 Aug 1969. (In French).

A device for transferring samples, irradiated in a swimming pool pile, into a transfer channel is described. It consists of a hood, affording protection against radiations, a receptacle open at its upper end, and a sleeve leading to a rabbit and a vessel which receives the samples and transports them. (France)

18414 SIMPLE AUTOMATIC APPARATUS FOR THE CLASSIFICATION OF CONTAMINATED TEST-TUBES. Erban, Jiri; Pilar Alexandr; Husak, Vaclav (University Hospital, Olomouc, Czech.). Jad. Energ.; 18: No. 2, 53-6(Feb 1972). (In Czech).

The construction of a simple automatic apparatus for sorting of contaminated test tubes is described. The apparatus has the capacity to hold and classify 50 test tubes according to the counting rate limit chosen in advance. The sorting equipment is connected to the scaler VA-M-16 (Vakutronik Dresden). In connection with the spectrometer VA-M-120, it is possible to use the apparatus as a changer for automatic measurement of samples in usual test tubes. (auth)

Transportation

Refer also to abstract 18408.

18415 (BNWL-SA-3906) PROCEEDINGS OF THE THIRD INTERNATIONAL SYMPOSIUM ON PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS, RICHLAND, WASHINGTON, AUGUST 16-20, 1971. (Battelle Pacific Northwest Labs., Richland, Wash.). 1971. 367p. (CONF-710801-(Vol.3)). Dep. NTIS.

Eighteen papers presented at the conference on packaging and transportation of radioactive materials are included in this volume. A separate abstract was prepared for each of 17 papers. One paper appeared previously in NSA as 25:44572. (L.C.L.)

For abstracts of individual papers see: 18416-18432.

18416 (BNWL-SA-3906, pp 75-95) TRENDS IN NUCLEAR TRANSPORTATION. Tremmel, Ernest B.; Berte, Robert J. (Division of Industrial Participation (AEC), Washington, D. C.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

Recent trends in nuclear transportation are discussed in terms of the developing nation-wide nuclear power plant system, the requirements for spent fuel shipments including the quantity and types of shipping containers which will be needed, and the requirements for future radioactive waste management. (L.C.L.)

18417 (BNWL-SA-3906, pp 96-107) TRANSPORTATION SAFEGUARDS. Crowson, Delmar L. (Office of Safeguards and Materials Management (AEC), Washington, D. C.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The development since 1967 of safeguards for the transportation phase of the management of special nuclear materials is discussed. Safeguarding of nuclear materials in transport has been accomplished by exclusive use of vehicle, access authorization, constant surveillance, convoys, and monitors. No known hijacking or theft

of nuclear materials in transit has occurred, but several misroutings have taken place. The materials are most susceptable to either misrouting or theft when being handled or temporarily stored at stops in the transport route. It is therefore recommended that monitors be provided at scheduled transfer points to observe the handling of shipments during these stops, and that some response force capabilities should be developed for protecting the special nuclear materials in transit. (L.C.L.)

18418 (BNWL-SA-3906, pp 108-29) AEC ACCIDENT RECORD AND RECENT CHANGES IN AEC MANUAL CHAPTER 0529. McCluggage, W. C. (Division of Operational Safety (AEC), Washington, D. C.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

Tabulated data are presented on AEC experience for the period from 1949 to 1971 with transportation accidents involving radioactive materials, including those that are fissionable. Recent changes in the AEC Manual 0529, "Safety Standards for the Packaging and Radioactive and Fissile Materials", are reviewed. The most significant of these changes is the inclusion of approval requirements and procedures for Type B packaging. (L.C.L.)

18419 (BNWL-SA-3906, pp 130-6) "CELOTEX": INSULATED SHIPPING CONTAINERS. Lewallen, E. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

Seven different kinds of packages for shipping radioactive materials were developed at Savannah River Plant using Celotex for thermal and shock protection. Twenty packages were dropped 30 feet at least once and eight packages were furnace tested at 1475°F. Military Standard drums were specified for all packages because of stronger construction and closer tolerances. Clearances between the Celotex, the drum, and the inner container were minimized. Criteria for locking-ring tightness were established. The maximum allowable weight of a package with a 16-gage, 55-gallon drum was estimated to be about 600 pounds. Since Celotex is combustible and evolves gases when heated, drums were vented to avoid rupture in the furnace test. To prevent smoldering of Celotex after removal from the fire, refractory insulation material was placed adjacent to the vent holes to retard air flow into the drum. Samples of Celotex were heated at 250°, 300° and 350°F for 14 days. Compressive stress tests of the samples showed minimal effect on those that had been heated at 250°F. Above 280° to 290°F significant mechanical degradation occurs. Celotex smolders at 400°F and burns rapidly at 425°F. Results showed that Celotex may be used successfully as an insulation material to comply with regulations for Type B packages. (auth)

18420 (BNWL-SA-3906, pp 145-59) PRACTICAL EXPERIENCE IN SPENT FUEL SHIPPING AND RELATION TO CASK CONCEPTS. Blum, Paul; Baatz, Henning; Mangusi, John (Transnuclear, Inc., New York). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

A large number of shipments of spent fuel from 35 reactors to 9 reprocessing plants have given unprecedented experience in this field but not without encountering problems. Some of these problems are described, and some safe and economical solutions with relation to cask concepts indicated. (auth)

18421 (BNWL-SA-3906, pp 160-71) EFFECT OF HIGHWAY WEIGHT RESTRICTIONS ON THE COST OF SPENT FUEL SHIPMENTS. Dufrane, K. H.; North, E. D. (Nuclear Fuel Services, Inc., Wheaton, Md.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The uneconomical aspects of rail transportation to many reactor sites combined with the large fraction of sites without direct rail access necessitates the development of an economic highway transportation system for handling spent reactor fuels. State Highway limitations on both weight and operating times provide economic restrictions which are critically amplified because of the low fuel payload carried relative to the shielded cask weight. For a selected typical case of an overweight cask carrying 3 PWR fuel assemblies in a 500 mile transport, the use charge for the cask alone almost doubles due to driving restrictions. If weight restrictions reduce the cask carrying capacity from 3 to 2 PWR assemblies per trip, an additional cost penalty of over 30% is found. This latter increase is further enhanced if the economics of site associated activities such as load-unload (turnaround) costs are also included. (auth)

18422 (BNWL-SA-3906, pp 172-81) REQUIREMENTS FOR DEVELOPMENT OF SPENT FUEL SHIPPING CASKS. Walchli, H. E. (Westinghouse Electric Corp., Pittsburgh, Pa.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The status of shipping cask design innovation has been retarded by the lack of common understanding and coordination between the utilities, the reprocessors and the cask designers. Current cask designs and shipping methods are not significantly different from the designs of 15 years ago. Experience in the shipping of spent fuel indicates that elimination of the need for decontamination would remove one of the largest labor and time consuming problems. To do this the entire system of fuel storage, cask handling, and transporting vehicle must be examined as a unified system. The large number of casks needed and the capital requirements indicate that action should be taken now to examine the feasibility of new concepts. Fuel and cask handling facilities should include adequate provisions in original plant construction to carry out necessary operations without need to backfit to each type cask. Increased attention should be given to personnel radiation exposure and safety in handling procedures. (auth)

18423 (BNWL-SA-3906, pp 182-92) DEVELOPMENT OF DOCUMENTATION FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. Fairey, J. (Atomic Weapons Research Establishment, Aldermaston (England)). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

A documentation system has been developed to deal with the complexities of national and international movement of radioactive materials and the methods and forms used for this and the special requirements of fissile material movement are detailed. (auth)

18424 (BNWL-SA-3906, pp 204-26) CALCULATIVE METHOD FOR DETERMINING EFFECTS OF THE 30-MINUTE FIRE ON LEAD SHIELDED CASKS. Glynn, J. C. (Division of Reactor Licensing (AEC), Washington, D. C.); Odegaarden, R. H. (Division of Materials Licensing (AEC), Washington, D. C.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

A study was made to develop a framework of data which could be used to predict the thermal effects of the prescribed 30-minute fire on lead filled casks once certain specific design parameters of the package are known. The study utilized a two-dimensional transient heat conduction program (ORTHAT) which handles the cylindrical geometry of shipping casks used to transport irradiated fuel elements. The radial and axial thickness of the lead and outer steel shell were varied along with the cavity size. Both finned and unfinned stainless steel and unfinned mild steel outer shells were considered. In order to examine the effects of possible convection within the molten lead, the thermal conductivity of the lead was arbitrarily doubled in some cases. The data show that the melting-front can be restricted if the outer surface of the cask is properly finned. Furthermore, the presence of voids at the cask corners would reduce the amount of lead that will melt. (auth)

18425 (BNWL-SA-3906, pp 227-40) EVALUATION OF PRODUCT FORM IN SAFETY OF PLUTONIUM TRANSPORTATION. Knights, L. M. (Atlantic Richfield Hanford Co., Richland, Wash.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

An evaluation is presented of the safety aspects of shipping reactor fuel-grade plutonium in various forms. The relative risks for shipment of metal, nitrate, and oxide are examined; and economic and operational effects are considered. (auth)

18426 (BNWL-SA-3906, pp 241-3) EFFECT OF PLUTONIUM NITRATE SHIPPING ON THE REACTOR FUEL FABRICATOR. Olson, R. E.; Knudsen, I. E.; Bullock, T. P. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The fuel fabricator should be able to maintain the option of receiving Pu in the form of nitrate or oxide. Restrictions on shipping either form will impose restrictions on fuel fabrication. Receiving Pu as nitrate gives the fuel fabricator more flexibility and better process and quality control. For safety considerations, there is no advantage of either oxide or nitrate using present shipping criteria, i.e., each has been shown to be safe. (auth)

18427 (BNWL-SA-3906, pp 244-60) SIMPLE SHIPPING SYSTEM FOR POWER GRADE PLUTONIUM OXIDE. Giebel, R. E.; Leebl, R. G. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

A primary experimental shipping container has been developed which utilizes magnesium oxide sand for heat transfer purposes. The experimental container has been used to ship plutonium oxide

with a specific power output of ~4 W/kg. The primary container was designed to fit the 6M shipping system which has D.O.T. approval. This container was not designed to serve for storage purposes and is recommended for shipping only. The plutonium oxide is loaded into the primary container which is a nominal 1½ in.-dia by 6 in. long stainless steel pipe with a wall thickness of 0.145 in. The pipe is fitted with a threaded cap and a Teflon® gasket for sealing purposes. The loaded pipe container is removed from the glovebox line in a polyvinyl chloride (PVC) bag which serves as an alpha contamination barrier. The bagged pipe is placed into a No. 901 mild steel can. The unoccupied annular space in the can is filled with magnesium oxide sand and the can is sealed with an automatic sealer. The sand-filled, sealed 901 can is subsequently placed in the 6M shipping container for transport off site. This shipping arrangement will accommodate about 800 g of plutonium oxide per container. Construction, utilization, and comparison with other shipping systems employed by Rocky Flats are discussed. The formulation of design criteria based upon heat transfer calculations and experimental temperature measurements are also reviewed. (auth)

18428 (BNWL-SA-3906, pp 261-9) FUTURE TRENDS IN FREIGHT HANDLING SYSTEMS. Davis, James R. (Drake Sheahan/Stewart Dougall, Inc., New York). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The air, rail, highway, and water modes of transporting materials in the US, improvements in materials handling equipment and methods in each of these modes, particularly in highway transport, the general state of technology in the transportation industry in the US and in Europe, and prospects for advancement in automation and standardization are briefly reviewed. (L.C.L.)

18429 (BNWL-SA-3906, pp 270-87) SHIPPING CASKS FOR SPENT FUEL WITH HIGH BURNUP. Dietrich, R.; Moryson, H.; Schmiedel, F. ([Fried-Krupp G.m.b.H., Industriebau und Maschinenfabriken, Essen (West Germany)]). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

A parametric study was made of heat removal and gamma and neutron shielding problems related to casks for shipping spent fuel elements. Fuel elements of a 1000 MW Na-cooled fast breeder-reactor were used in the calculations. Calculations were made for different numbers of fuel elements per cask. The shielding material was steel and depleted uranium. The most significant results such as temperature distribution in the cylindrical wall of the cask and the shielding effect of the steel-uranium shielding configuration are illustrated. (auth)

18430 (BNWL-SA-3906, pp 288-97) GENERAL ELECTRIC COMPANY IF 300 SPENT FUEL SHIPPING CASK DESIGN EXPERIENCE. Jones, R. H.; Smith, C. W. (General Electric Co., San Jose, Calif.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The concept, development, and final design of the General Electric IF 300 spent fuel shipping cask is described in detail. This design is primarily a rail transported cask. However, the system has provisions for over-the-road movement to service those reactor sites that do not have a rail siding. This highway movement is only from the reactor site to the nearest suitable railroad location where the cask is loaded onto its railcar using a modified "piggyback" technique. The structure consists of two stainless steel shells surrounding depleted uranium metal shielding. One unique feature of the cask is its corrugated water jacket. This stainless steel structure provides containment for the neutron shielding medium and also presents a large area for the dissipation of heat. The continuous convolutions also create a smooth surface which will greatly reduce the decontamination time. Since the jacket is only ⅛ inch thick, it does not add significantly to the cask weight, although the corrugations make the jacket structurally quite rugged. Another unique feature is the forced-air exterior cooling system, which efficiently removes large amounts of decay heat without requiring the closed loop/heat exchanger devices of other large casks. The IF 300 cask holds either 18 BWR or 7 PWR fuel assemblies. This is accomplished with interchangeable baskets and heads. The cask itself weighs approximately 65 tons and the total package weighs about 85 tons. (auth)

18431 (BNWL-SA-3906, pp 298-318) ECONOMIC AND ENGINEERING ANALYSIS OF A UNIT TRAIN CONCEPT FOR THE TRANSPORTATION OF SPENT FUEL ASSEMBLIES FROM COMMERCIAL NUCLEAR POWER PLANTS. Trudeau, Arthur G. (North American Rockwell Corp., Washington, D. C.); Haagensen, Darrow E. (Energy Consultants, Inc., Chevy Chase, Md.). 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The construction of a large number of large commercial nuclear power plants in the United States in the coming decade will present some interesting and difficult problems with respect to the transportation and handling of spent nuclear fuel assemblies from these utility plants to reprocessing plants. It appears that, where practicable, a unit train concept for the complete shipment of spent nuclear fuel assemblies from a particular plant on an annual basis may be not only the safest and fastest, but also the most economical means of transportation. It is also evident that the problem of the attenuation of neutrons from spent fuel assemblies with high burnup rates requires the development of greatly improved casks. In this connection the problems of safe and rapid handling also favor the development of designs and techniques that eliminate the need for raising and lowering very heavy casks in and out of the spent fuel pools. (auth)

18432 (BNWL-SA-3906, pp 331-67) HIJACKING AND PILFERAGE PROBLEM. Panel Discussion. 1971.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The hijacking and theft problems related to special nuclear materials transport are discussed by a panel of experts representing the USAEC, US Senate, US Dept. of Transportation, the insurance industry, overall transportation industry, American Trucking Assn., and Air Transport Assn. of America. Although there is no known case of theft of special nuclear material in the transport cycle to date, the growth of nuclear power involves a projected 100- to 1000-fold increase in the number of shipments of nuclear materials. Therefore, development of methods for the prevention of theft and the detection, location, and recovery of stolen nuclear material becomes increasingly significant. (L.C.L.)

18433 (ORNL-TM-3651) PARAMETRIC STUDY OF SHIPPING CASKS FOR SOLID RADIOACTIVE WASTES. Perona, J. J.; Blomeke, J. O. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 42p. Dep. NTIS.

In view of the present requirement that the high-level liquid wastes from reprocessing spent fuels be solidified for eventual shipment to a federal repository, a study was made of the design features of casks for shipping solid wastes that are encapsulated in cans 6 to 24 in. in diameter by 10 ft long. Lead, iron, and depleted uranium were investigated as shielding materials, and casks were designed to dissipate the decay heat by conduction and radiation using internal metal inserts and external circumferential fins. Data are presented from which economically optimal designs can be specified, based on the number and diameter of waste cans per shipment, and on the age and concentration of the radioisotopes within the waste solids. (auth)

18434 PEACH BOTTOM SPENT FUEL ELEMENT SHIPPING CASK (27 Feb 1970) (Engineering Materials). (Gulf General Atomic, Inc., San Diego, Calif.). (CAPE-2167).
17 drawings.

The Peach Bottom shipping cask for spent fuel elements is described. The cask is a modified Hallam reactor shipping cask designed by Atomics International. The modifications make the cask satisfy the requirements of 10-CFR-71 of AEC Rules and Regulations for packaging of radioactive materials for transport. (For details see TID-4100, Suppl 68) (see also NSA 25: 44566) (F.S.)

18435 ION EXCHANGE VESSEL HAVING HOLLOW CYLINDRICAL RING CONSTRUCTION FOR THE TRANSFER OF A RADIOACTIVE SUBSTANCE. Pierlas, Rene Antony; Courouble, Jean Marie (to Commissariat a l'Energie Atomique). U. S. Patent 3,626,191. 7 Dec 1971. Priority date 28 Feb 1968, France.

A vessel for the purpose of transferring a radioactive substance, which is adsorbed on an ion exchanger in the granular state is described. The ion exchange column is in the form of a cylindrical ring and is surrounded by a shield having good thermal conductivity. The column has at least one pipe for the supply of radioactive solution which penetrates into the column and at least one pipe for the discharge of the solution. (Official Gazette)

PARTICLE ACCELERATORS

Design, Development, and Operation

18436 (JINR-P9-6166) EXPERIMENTS ON THE Xe ION ACCELERATION IN THE JINR CYCLOTRONS. Shelaev, I. A.; Alfeev, V. S.; Batyunya, V. V.; Zager, B. A.; Kozlov, S. I.; Mel'nikov, V. N.; Oganesyan, R. Ts.; Filipson, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The experimental results are presented on the Xe ion acceleration in tandem-cyclotrons of the Laboratory of Nuclear Reactions (JINR). The Xe ion beams with the energy of (5 to 7) MeV/nucleon and intensity of (3.10^9 to 2.10^8) freq-sec, respectively, are obtained. (auth)

18437 (LBL-308) PERFORMANCE OF THE BEVATRON WITH HEAVY IONS. Grunder, H. A.; Guggemos, J. R.; Lothrop, F. H. G.; Tekawa, M. M. (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1971. Contract W-7405-eng-48. 7p. (CONF-711021-9). Dep. NTIS.

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

Performance data on the acceleration of deuterons, alphas, and nitrogen ions at 0.280, 1, and 2.1 GeV/nucleon in the Bevatron are presented and discussed. The injection and acceleration, extraction, and transport and target facility are briefly described. (W.H.K.)

18438 (ORNL-TM-3680) SAFETY ANALYSIS OF SOLID STATE DIVISION 2,5 MV ELECTRON ACCELERATOR. Schow, O. E. (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 11p. Dep. NTIS.

The Van de Graaff accelerator stop switches, protective door interlock switches, accelerator keys, belt drive motor system, visual and audible alarms, radiation instruments, startup alarms, emergency lights, and radiation shielding are described. Also, other hazards including the high-pressure accelerator tank, high vacuum equipment, fire safety, electrical safety, ozone, and the tv camera system are discussed. (W.H.K.)

18439 ACCELERATOR FOR RELATIVISTIC ELECTRONS. Epsztein, Bernard; Pinel, Jacques (to CSF Compagnie Generale de Telegraphie). U. S. Patent 3,611,166. 5 Oct 1971. Priority date 21 Nov 1967, France.

An electron accelerator supplied with H. F. energy comprising one or more resonators in series through which an electron beam is propagated several times along parallel trajectories with deflection by 180° at each end of the accelerator is described. (auth)

18440 BETATRON. Anan'ev, Lev Martemianovich; Pekker, Yakov Semenovich; Chakhlov, Vladimir Lukianovich; (and others). U. S. Patent 3,614,638. 19 Oct 1971. Filed 7 May 1969.

A betatron, comprising an electromagnet having a pair of opposing poles spaced adjacent to one another and acting to transfer a magnetic flux in a zone therebetween, is provided with an acceleration vacuum vessel interposed between the poles. An injector is mounted internally and includes an electron emissive filament. A winding coil is connected to one of the pole and surrounds the flux zone. The filament is electrically coupled with the winding for heating by electrical energy induced in the winding in response to the magnetic flux. (auth)

18441 CHARGE EXCHANGE FOR HEAVY ION ACCELERATORS. Tonuma, Tadao (Inst. of Physical and Chemical Research, Wako, Japan). Rikagaku Kenkyusho Hokoku; 47: No. 5, 153-60(Sep 1971). (In Japanese).

In modern physics it is required to accelerate heavier particles than those formerly used to higher energies, and now the acceleration of uranium ions up to 2 GeV is aimed at. To realize this requirement, it is more advantageous to accelerate heavy ions by a multiple stage accelerator, which uses gases or foils as the stripping material and utilizes charge exchange phenomena of ions, rather than by a single stage accelerator. The charge exchange problem for heavy ion accelerators is reviewed, based on experimental data already reported. (auth) (Japan)

18442 HIGH VOLTAGE PARTICLE ACCELERATORS. (to Nuclear-Chicago Corp.). British Patent 1,255,341. 1 Dec 1971. Priority date 5 Apr 1968, United States.

A high-voltage accelerator system with an ac ion source and annular-electrode accelerating structure is described. The dc voltages may range from 100 to 1000 kV. (W.H.K.)

18443 CHARGED RELATIVISTIC ELECTRON RING IN A HELICAL MAGNETIC FIELD. Bonch-Osmolovskii, A. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1059-64 (Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1345-52(Jul 1971).

The equilibrium of a charged ring of relativistic electrons in a uniform, weakly focusing magnetic field with an azimuthal component $H_\varphi = \kappa/r$ is discussed. It is shown that the radius of rotation of the electrons can be kept almost constant in a helical magnetic field that changes adiabatically in space. (auth)

18444 ACCELERATION OF NITROGEN IONS TO 7.4 GeV IN THE PRINCETON PARTICLE ACCELERATOR. White, M. G.; Isaila, M.; Prelec, K.; Allen, H. L. (Princeton Univ., N. J.). Science; 174: No. 4014, 1121-3(10 Dec 1971).

Nitrogen ions in charge states N^{5+} and N^{6+} have been accelerated in the Princeton Particle Accelerator to 4 and 7.4 billion electron volts (GeV), respectively. An external N^{5+} beam of 1×10^6 particles per second has been obtained and focused to a 6-millimeter-diameter spot. The N^{6+} beam was about 2×10^5 particles per second. The total charge-changing collision cross section of N^{5+} in water vapor was determined as a function of ion energy. The improvement in vacuum necessary to increase the N^{5+} beam at least tenfold was calculated. The N^{6+} total cross section is probably smaller than that of N^{5+} at the higher energies. (auth)

18445 ACCELERATION OF HEAVY IONS AT THE BEVATRON. Grunder, H. A.; Hartsough, W. D.; Lofgren, E. J. (Univ. of California, Berkeley). Science; 174: No. 4014, 1128-9(10 Dec 1971).

Substantial beams of deuterons, α-particles, and nitrogen ions have been accelerated to high energies (nitrogen to 36 billion electron volts) in the Bevatron. Beams of various energies were successfully extracted for experimental use. Modifications of the ion source, the injector, and the main acceleration system made the production of high-energy heavy ions possible. The computer control system played an important part. (auth)

Auxiliaries and Components

Refer also to abstracts 17843 and 18951.

18446 EXPERIENCES AND PROBLEMS ON DESIGN AND CONSTRUCTION OF RADIATION SHIELDING. I. RADIATION SHIELDING FOR ACCELERATORS. Okajima, Nobuo (Taisei Construction Co. Ltd., Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 7, 387-92(Jul 1971). (In Japanese).

For the planning of radiation shielding for high energy charged particle accelerator facilities, it is necessary to make detailed analysis of spatial distributions and densities of relevant radiation sources of all sorts, and moreover to work out the most effective plan for radiation shielding for protection against contamination and for decontamination. Typical problems in the design of radiation shielding for high energy charged particle accelerator facilities are discussed. The importance of geological considerations, optimization techniques for the layout of the facilities, and results of various measurements actually performed are described. (Japan)

18447 STABILIZATSIYA I REGULIROVANIE VYSOKOCHASTOTNYKH POLEI V LINEINYKH USKORITELYAKH IONOV. (Stabilization and Regulation of High Frequency Fields in Linear Ion Accelerators). Murin, B. P. Moscow; Atomizdat (1971). 336p.

Methods of stabilizing the energy of accelerated beams and of regulating the phase of hf fields are discussed. Random changes in these fields and their compensation, and systems for automatic adjustment of resonators are considered. A portion of the book focuses attention on disturbances in high frequency fields resulting from variations in the supply voltages and resonator loadings by intense beams of accelerated particles. Operating linear accelerators over the world are listed and compared. (107 references.) (K.S.W.)

18448 RADIO-FREQUENCY SYSTEM OF THE SYNCHROCYCLOTRON AT THE PHYSICOTECHNICAL INSTITUTE, ACADEMY OF SCIENCES, USSR. Abrosimov, N. K.; Alkhazov, D. G.; Dmitriev, S. P.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 963-9(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1222-30(Jun 1971).

The radio-frequency (hf) system of the synchrocyclotron in

operation at the Physicotechnical Institute, Academy of Sciences of the USSR, is described. The design of all the basic units of the system and their electrical characteristics are given. The mechanical and thermal load characteristics are also given. The power loss due to eddy currents in the rotors in the fringing field of the electromagnet is estimated. Measures for suppressing the parasitic oscillations of the tuner are discussed. Results obtained in compensating for the dependence of the frequency on the rotation angle of the tuner are given. (auth)

18449 METHODS FOR TREATING CONSTRUCTIONAL ERRORS IN WAVEGUIDES IN ELECTRON LINEAR ACCELERATORS. Aver'yanov, G. P.; Nesterovich, A. V.; Shal'nov, A. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 970-4(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1231-6(Jun 1971).

The effect of inaccuracies in the construction of uniform disk-loaded waveguides on the acceleration of relativistic particles is examined. The dependence of the energy acquired by the particles on various factors has been studied: intensity of the beam, entrance phase, and density distribution of the particles in a bunch. It is shown that there is a relation between the fabrication errors and instabilities in electron linear accelerators. Aside from a mean energy loss, inaccuracies in the construction can also distort the energy spectrum of the particle bunch. The effect of distribution of nonuniformities along the length of a disk-loaded waveguide on the energy characteristics of the particle bunch is indicated. Statistical modelling using a computer (Monte-Carlo method) has been used in this work. The use of this method makes it possible to increase considerably the accuracy with which the effect of errors in the construction of waveguides can be treated; it is also to consider the effect of various factors on tolerances in the construction of accelerating structures. (auth)

Ion Sources, Injection, and Extraction

18450 (LBL-304) PULSED HEAVY ION SOURCE FOR THE BEVATRON. Grunder, H. A.; Richter, R. M.; Tekawa, M. M.; Zajec, E. (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1971. Contract W-7405-eng-48. 5p. (CONF-711021-8). Dep. NTIS.

From International conference on multiply-charged ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

A Phillips' ion gauge source of the type used by the heavy ion accelerator in Berkeley has been adapted for use at the Bevatron. The objective was to achieve high charge state ions (4+, 5+) of carbon and nitrogen. All source parameters are pulsed. The ion source performance regarding linac acceleration is discussed. The light ion (deuteron, alpha) performance of the PIG source and duoplasmatron is compared. (auth)

18451 PLASMA ION SOURCE. Grigor'ev, Yu. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 909-14(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1151-8(Jun 1971).

A semiempirical formula is obtained for the geometric parameters of a slit-type accelerating system which provides minimum angular divergence of the ion beam. The derivation is based on the determination of the density of the emitting current in a planar two-electrode system. The applicability of the formula and possible errors are discussed. (auth)

18452 PERFORMANCE ESTIMATES OF A MEDIAN PLANE INJECTION SYSTEM FOR THE MICHIGAN STATE UNIVERSITY CYCLOTRON. Dreisbach, John. East Lansing, Mich.; Michigan State Univ. (1971). 107p. University Microfilms Order No. 71-31,189.

Thesis.

Ions from an external source can enter the central region of a sector focused cyclotron by winding along a sector edge in the median plane. To use this method with the MSU cyclotron, the injected beam first travels along the inside of the dee stem to an "outer" electrostatic inflector located at a slightly greater radius than the last accelerated orbit. This outer inflector shifts the ions onto a cycloid-like trajectory, the drift of the cycloid carrying the particles inward, approximately following an iso-gauss contour at one of the hill-valley transitions of the sectored magnet. After approximately 35 cycles or "turns" of the cycloidal motion, the ions end up in the central region of the cyclotron where an "inner" electrostatic inflector system guides them onto a suitable normal orbit. The focusing properties of such an injection system were thoroughly investigated for the case of protons with a final cyclotron energy of 42 MeV. One of the primary motivations for external injection systems is acceleration of polarized ions using some form of polarized ion source. So the influence of the cycloid-like motion on the polarization of protons was calculated: there is essentially no depolarization. If a polarized ion source having a luminosity which seems feasible today is used with this injector, the estimated current out of the cyclotron should be around 50 nA. The radial acceptance of the proposed system is about a factor of 4 or 5 times smaller than that obtained with some existing injectors; and the axial acceptance, somewhat smaller. The energy spread of the beam from the cyclotron should be slightly better than elsewhere because the proposed duty factor is smaller. Finally the estimated increase in horizontal emittance is similar in magnitude to that found elsewhere. (TSS) (Diss. Abstr. Int., B)

18453 MAGNETICALLY SELF-SHAPING SEPTUM FOR BEAM DEFLECTION. Hudson, Ed D. (to United States Atomic Energy Commission). U. S. Patent 3,624,527. 30 Nov 1971. Filed 15 Sep 1970.

A beam deflection septum magnet assembly for separating an extracted beam from a confined beam of a cyclotron is described. The separating member is a thin current-carrying sheet conductor that is self-shaping and assumes the same radius of curvature as the beam to be deflected when the end points are properly adjusted. The maximum field reduction obtained is limited mainly by the tensile strength of the septum and by the power that can be removed from the thin sheet conductor. (auth)

Ion Optics and Field Calculations

18454 IMAGING PROPERTIES OF A NOVEL ELECTROSTATIC LENS. Youssef, E. A.; Vermeulen, F. E.; Chute, F. S. (Univ. of Alberta, Edmonton). Can. J. Phys.; 49: No. 21, 2651-8 (1 Nov 1971).

A study is made of the imaging properties of an electrostatic quadrupole that was uniformly twisted about its axis. It is shown that the structure is capable of identically reproducing the injection coordinates and momenta of a system of particles in a coordinate plane which is located some distance along the quadrupole. The imaging takes place with a small amount of aberration. This aberration can be greatly reduced by constructing the lens of two sections which follow each other and which have equal and opposite twists. (auth) (Canada)

18455 FOCAL LENGTH OF A TWO-DIMENSIONAL LENS. Brodskii, G. N.; Yavor, S. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1218-19(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1550-2(Jul 1971).

Equations for the focal length of a two-dimensional electrostatic lens are derived. (W.H.K.)

18456 ABERRATIONS IN SUPERPOSED MAGNETIC QUADRUPOLE AND DEFLECTING FIELDS. Ovsyannikova, L. P.; Yavor, S. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1213-15 (Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1544-7(Jul 1971).

Aberrations of quadrupole lenses with asymmetric feed whose fields are superpositions of quadrupole and deflecting fields are examined. Expressions for the aberration coefficients are presented in quadratures. The integration is performed in the thin-lens approximation. (auth)

18457 EFFECT OF THE WINDING THICKNESS ON THE ELECTRON-OPTICAL PARAMETERS OF AIR-CORE MAGNETIC LENSES. Basin, L. A.; Bobykin, B. V.; Davydovskii, V. Ya.; Ermekov, N. T.; Kel'man, V. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1168-70(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1485-8(Jul 1971).

Equations are derived for the corrections to the electron-optical parameters of axisymmetric distributed-winding magnetic lenses due to the finite thickness of the winding. It is shown that the results apply to lenses encountered in practice. (auth)

18458 ELECTRON BEAM IN A LINEAR INDUCTION ACCELERATOR. Matora, I. M.; Merkulov, L. A.; Shelontsev, I. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1155-7(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1469-71(Jul 1971).

It is shown that the main loss in an intense laminar beam of electrons accelerated in a linear induction accelerator occurs at the leading and trailing edges of the induction pulses of the inductors. Measures are proposed for reducing the loss of accelerated electrons. Various electron-injection programs are analyzed. (auth)

18459 ELECTROSTATIC CYLINDRICAL ELECTRON MIRRORS. Kel'man, V. M.; Fedulina, L. V.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1171-6(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1489-97(Jul 1971).

A procedure is given for calculating aberrations in electron mirrors. The aberrations of an electrostatic cylindrical electron mirror are calculated. (auth)

18460 EXPERIMENTAL INVESTIGATION OF STABILITY IN A MICROTRON. Kosarev, E. L. (Inst. of Physical Problems, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1142-9(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1452-61(Jul 1971).

The beam interaction with the accelerating field of a microtron resonator is studied. The measurements were carried out on the microtron of the Institute for Physical Problems, Academy of Sciences of the USSR, at a beam energy of 18 MeV and currents up to 70 mA per pulse. The frequency shift of the resonator due to the accelerated beam, the beam stability as a function of the current, and the resonator tuning were measured for different values of the equilibrium phase. Eigenoscillations of the microtron have been observed for the first time. The results of the measurements are found to be in good agreement with previous results. (auth)

18461 ACCELERATION OF MODULATED BEAM OF CHARGED PARTICLES IN MEDIUM WITH INVERTED POPULATION LEVELS. Krasovitskii, V. B. (All-Union Scientific-Research and Design Inst. of Electrical Apparatus, Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 864-6 (Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1093-5(Jun 1971).

The acceleration of a modulated beam consisting of a train of charged bunches in a medium with inverted population levels is investigated. It is shown that there are nonlinear conditions for which the beam trapped by the wave is in resonance during the entire acceleration process and the energy stored in the medium is completely converted to beam energy. (auth)

18462 CORRECTION OF ABERRATION IN A QUADRUPOLE–OCTUPOLE LENS FOR A WIDE FIELD OF VIEW. Baranova, L. A.; Ovsyannikova, L. P.; Yavor, S. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 1040-2(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1323-6(Jun 1971).

The correction of spherical aberration, oblique-beam aberrations, and other aberrations in quadrupole lenses using octupole lenses is studied. (W.H.K.)

18463 INTERACTION OF A TRAIN OF ELECTRON BUNCHES WITH A WAVEGUIDE STRUCTURE. Gross, L. P.; Ivanov, G. M.; Makhnenko, L. A.; Shal'nov, A. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 995-8(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1267-71(Jun 1971).

The interaction of a train of relativistic electron bunches with an iris-loaded waveguide is considered. The functional dependence of the amplitude of the high-frequency field, induced by the bunches, on the difference between the particle and wave velocities is obtained. The experimentally obtained dependence is in agreement with the theoretical prediction. (auth)

18464 MAGNETICALLY-BRAKED RADIATION. Kapitsa, S. P. (Inst. of Physical Problems, Moscow. Moscow Physical-Technical Inst.). Priroda; No. 10, 22-7(Oct 1971). (In Russian).

Synchrotron radiation and the mechanism of its formation are discussed with the movement of an electron through a magnetic field as the theoretical basis. The principle of a storage ring is explained, and apparatus for the production of synchrotron radiation is outlined as exemplified in a 15 MeV microtron with target and resonator. (K.S.W.)

18465 NOTE ON WAIST-TO-WAIST TRANSFER IN PARTICLE OPTICS. Glavish, H. F. (Stanford Univ., Calif.). Nucl. Instrum. Methods; 99: No. 1, 109-14(1972).

Equations are obtained for waist-to-waist transfer for thick lens elements. The equations are simplified by considering the transfer between the focal planes of a lens. Examples are given. (auth)

18466 CORRECTION OF GEOMETRICAL ABERRATIONS IN ELECTRON-OPTICAL SYSTEMS BY OCTUPOLES. Yavor, S. Ya.; Ovsyannikova, L. P.; Baranova, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods; 99: No. 1, 103-8(1972).

Expressions for the coefficients of all third-order geometrical aberrations in systems of arbitrary numbers of lenses are obtained. The formulas for aberration coefficients of the octupoles, both spatially superimposed on the quadrupole lens and detached, are written in the form of quadratures as well as in the analytical form in the short-lens approximation and for a rectangular model. The possibility of correction of aberrations in a system by octupoles is investigated. (auth)

Storage Rings

18467 (LNF–71/55) DESIGN ELEMENTS OF MAGNETIC STRUCTURE OF A 4-GeV ELECTRON–POSITRON DOUBLE STORAGE RING WITH INSERTION OF LOW-BETA SECTIONS. Renieri, A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 7 Sep 1971. 14p. (In Italian). Dep. NTIS (U. S. Sales Only).

The preliminary study of the magnetic structure of a high-luminosity crossed-beam machine with the characteristics of low beta in the crossed zone, two separate rings for e^+ and e^-, and small crossing angle is reported. A mixed deflection type, which uses both magnetic and electrical elements, was used in order to obtain a small crossing angle. The general characteristics of the machine are given. The low-beta section is described. The tolerance in the positioning of the Q_3-Q_4 quadrupoles is determined. The chromatic aberration and nonlinearity of the machine are calculated. (J.S.R.)

18468 RADIATIVE POLARIZATION OF ELECTRONS IN STORAGE RINGS. Baier, V. N. Usp. Fiz. Nauk; 105: No. 3, 441-78(Nov 1971). (In Russian).

The phenomenon of electron polarization which arises as a result of radiation during prolonged motion in a magnetic field is discussed. Within the framework of the quasi-classical operator method the probability of radiative transition with reversed spin in a magnetic field is discussed. A kinetic equation allowing for the effects of radiation is obtained for electron polarization in an external field, and with the aid of this equation the kinetics of radiative polarization is analyzed. Effects which lead to a depolarization of an electron beam in a nonhomogeneous magnetic field are examined. Methods for suppressing these effects and also the intentional depolarization of a beam are explained. Methods are detailed for measuring the transverse polarization of high-energy electrons, and the experiment in which the first indication of radiative polarization was obtained is described. (tr-auth)

18469 LONGITUDINAL BEAM INSTABILITY IN A STORAGE RING. I. Kononenko, S. G.; Lobzov, L. D.; Reprintsev, L. V.; Shenderovich, A. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 999-1005(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1272-80(Jun 1971).

The longitudinal instability of a beam resulting from its interaction with a passive resonator with known characteristics has been investigated theoretically and experimentally. Landau damping is introduced by solving the system of linear differential equations of the motion for N particles with different natural frequencies. (auth)

18470 LONGITUDINAL BEAM INSTABILITY IN A STORAGE RING. II. Kononenko, S. G.; Lobzov, L. D.; Reprintsev, L. V.; Shenderovich, A. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 1006-10(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1281-6(Jun 1971).

The longitudinal motion of a beam subject to induced voltages, synchrotron resonance, and synchrobetatron resonance has been investigated theoretically and experimentally. It is shown that the instability threshold is greatly increased (by a factor of a hundred) by resonance perturbations and that the effects of the resonances themselves are reduced on both the stable and unstable parts of the resonance curve. (auth)

Experimental Facilities

18471 (BNL–16437) ON THE QUESTION OF RF JOINTS IN SUPERCONDUCTING DEFLECTORS. Hahn, H.; Lazarus, D. M. (Brookhaven National Lab., Upton, N. Y.). 5 Jan 1972. 10p. Dep. NTIS.

The effects of fabrication tolerances on rf joints in superconducting deflectors for beam separators are analyzed by using an equivalent circuit description. It is found that pretuning of the deflectors essentially eliminates the joint problem. (auth)

18472 LIQUID NITROGEN CRYOSTAT FOR ANNEALING STUDIES OF METALS AFTER ELECTRON IRRADIATION. Duarte, L. R.; Spinelli, D. (Univ. of Sao Paulo, Sao Carlos, Brazil). Rev. Brasil. Technol.; 2: No. 1, 21-6(Mar 1971). (In Portuguese).

A liquid nitrogen cryostat has been designed for irradiation with 2 MeV electrons from a LINAC. The cryostat is provided with a special designed teflon valve operated by remote control in order to allow the passage of liquid N_2 from the N_2 well to a small cold-finger which is attached to the sample chamber. The variation of temperature is made by means of a heater surrounding the cold-finger. The sample chamber is designed for metal wires wound

in a square mica window so that 80% of the total length of the wire is irradiated by the electron beam. Behind the mica window there is a Faraday cage for the measurement of the integrated flux. The cryostat is vacuum connected to the accelerator by mean of an aluminium vacuum sealed thin foil (10 mil) and the scattering of the beam was observed to be acceptable inside the cryostat due to the vacuum connection. Quenching and annealing simulations were carried out showing that the cryostat is working in a satisfactory manner. The cryostat is used in the study of the Stages III and IV of the recovery of electrical resistivity of pure copper samples, but the sample holder is designed so that one can change the sample chamber in order to carry out internal friction studies at high frequencies. (auth)

18473 PROJECT NEUTRON DOSIMETRY AT THE PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT. Cosack, M.; Jahr, R.; Schoelermann, H.; Taubert, R.; Waibel, E. PTB Mitt.; 81: No. 5, 343-7(Oct 1971). (In German).

A survey on the scientific program and the experimental set-up is given for an accelerator facility for monoenergetic neutron production. The facility comprises a Van de Graaff-generator and a compact cyclotron. (auth)

18474 TARGET ASSEMBLY FOR A THERMAL NEUTRON GENERATOR. Dalrymple, Desmond G. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,623,130. 23 Nov 1971. Filed 16 May 1969.

A target assembly for a thermal neutron generator wherein an elongated target tube has a top end receiving liquid metal and a bottom end receiving a windowless proton beam tube is described. The liquid metal enters the target zone with a swirl causing the liquid metal to adhere to the wall of the target tube so as not to enter the proton beam tube. (auth)

18475 METHOD AND DEVICE FOR MODULATING OR STABILIZING A NEUTRON FLUX OBTAINED FROM AN ION ACCELERATOR. Pierson, Alexandre (to Commissariat a l'-Energie Atomique). British Patent 1,259,997. 12 Jan 1972. Priority date 28 Jun 1968, France.

The electrostatic deflection plates for deflecting the accelerator beam on the target are controlled by the output voltage of a neutron detector. (W.H.K.)

18476 OBJECT-POSITIONING LINKAGE HAVING A SINGLE-SHAFT PLURAL-PISTON ACTUATOR. Clay, Haile S. (to United States Atomic Energy Commission). U. S. Patent 3,622,830. 23 Nov 1971. Filed 11 Feb 1970.

A pair of targets one of which is positioned in the path of a particle accelerator beam or both of which are removed from the beam path is described. The targets are manipulated by means of a linkage which carries the targets in long vertical movements in response to short horizontal-actuating movements of dual coaxial pistons which differentially and reciprocably drive a single shaft through the short horizontal-actuating movements to drive the linkage to carry the targets to one of the three positions. (auth)

18477 NUCLEON AND CHARGED-PION ALBEDO SPECTRA IN AN ACCELERATOR CAVE FROM 200 GeV PROTON INTERACTIONS IN IRON. Gabriel, T. A.; Santoro, R. T. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 99: No. 1, 5-12(1972).

Nucleon and charged-pion albedo flux distributions in an accelerator cave resulting from the interaction of 200-GeV protons were calculated. The spectra are given as a function of secondary-particle energy and of radial position and distance from the point where the beam is dumped into the iron. Comparisons between the omnidirectional and "backward" flux distributions are presented. (auth)

18478 AUTOMATIC MEASUREMENT OF YIELD FUNCTIONS WITH AN ELECTROSTATIC ACCELERATOR. Lam, S. T. (Univ. of Toronto); Ferguson, A. J. Nucl. Instrum. Methods; 99: No. 1, 151-8(1972).

A system is described that uses a digital computer with appropriate hardware for controlling the beam energy of a tandem accelerator, the beam transport system, and counting equipment and that is capable of performing a complete yield-curve experiment. Several detectors of various kinds can be used, and all measured spectra are recorded on magnetic tape. Continuous records of the yields of any desired spectral features are maintained which can be displayed at any time throughout the experiment. (auth)

18479 BEAM HEATING IN GAS TARGETS. McDaniels, D. K.; Bergqvist, I.; Drake, D.; Martin, J. T. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 99: No. 1, 77-80(1972).

The correction for the change in density of molecules in gas targets as a function of beam current is investigated using both a pulsed and dc beam. The dominant physical mechanism is confirmed to be an overall heating of the gas for the type of target commonly used which has the incident beam stopping in the end foil of the gas cell. It is shown how this heating can be monitored and corrected for in a convenient and reliable manner. The effects of pulsing and possible temperature gradients are discussed. (auth)

18480 COMPUTERIZED NMR SYSTEM FOR POLARIZED TARGETS. Walraven, R. L. (Univ. of California, Davis). Nucl. Instrum. Methods; 99: No. 1, 73-5(1972).

The NMR system for the Davis polarized proton target is described. The system uses a series-resonant Q-meter circuit for detection, a voltage-variable capacitor for tuning, and a computer for time-averaging and recording of the NMR signal. (auth)

18481 FILTERED BREMSSTRAHLUNG FOR PHOTONUCLEAR REACTIONS. Toms, M. Elaine (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods; 99: No. 1, 45-8 (1972).

The use of graphite filtering of bremsstrahlung to reduce pile-up in detectors is highly desirable, as the low-energy portion is greatly reduced relative to the useful photons. To compare yields observed with filtered beams to those obtained with unfiltered beams, photon spectra for equal response of a standard monitor are needed. As earlier experiments used a Victoreen thimble in a standard lucite block, the response of this standard was investigated with filtered and unfiltered bremsstrahlung with the aid of a transmission ion chamber. The measurements agree well with calculations based on the theoretical response. (auth)

18482 TRITIUM TARGET FOR INTENSE NEUTRON SOURCE. Booth, R.; Barschall, H. H. (Univ. of California, Livermore). Nucl. Instrum. Methods; 99: No. 1, 1-4(1972).

A rotating target is described for an intense source of 14-MeV neutrons. For a fresh target the source strength is 2×10^{12} neutrons/s. The source strength decreases to half its initial value in about 100 h of continuous operation. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Refer also to abstract 18889.

18483 DYNAMO PROBLEM. Weiss, N. O. (Cambridge Univ., Eng.). Quart. J. Roy. Astron. Soc.; 12: No. 4, 432-46 (Dec. 1971).

A discussion based on Cowling's papers on the origin and maintenance of astronomical magnetic fields and the dynamo problem is presented. It is stated that the latter has not yet been fully solved, and most of the discussion presented is concerned with attempts to "get round" Cowling's theorem. A summary is given of relevant observations, followed by a discussion of the following topics, restricted to solar and terrestrial dynamo models; Cowling's theorem; spherical dynamo models; nearly axisymmetric dynamos; turbulent dynamos; current problems (dynamo equations; solar dynamo models; terrestrial dynamo models; axisymmetric velocities; time-dependent behavior; magnetohydrodynamic dynamos; and turbulent convection and magnetic fields). (UK)

18484 MAGNETOHYDRODYNAMICS OF ROTATING FLUIDS: A SUMMARY OF SOME RECENT WORK. Hide, R. (Meteorological Office, Bracknell, Eng.). Quart J. Roy. Astron. Soc.; 12: No. 4, 380-3(Dec 1971).

It is stated that the systematic study of the MHD of rotating fluids constitutes a comparatively new development in theoretical fluid mechanics, with numerous applications in geophysics and astronomy. An account is given of some characteristic features and associated development work. (UK)

18485 MAGNETIC FIELDS IN ASTRONOMY. Cowling, T. G. (Univ. of Leeds, Eng.). Quart. J. Roy. Astron. Soc.; 12: No. 4, 348-51(Dec 1971).

A review is presented of how the subject first developed, with summaries of some early work. (UK)

18486 MAGNETOHYDRODYNAMIC STABILITY PROBLEMS IN ASTROPHYSICS. Tayler, R. J. (Univ. of Sussex, Brighton, Eng.). Quart. J. Roy. Astron. Soc.; 12: No. 4, 352-62(Dec 1971).

In laboratory studies of plasmas confined by a magnetic field it is found that most configurations in which the plasma and magnetic pressures are comparable are unstable, and that the instability growth times are not much greater than the dynamical time scale of the system. Similar instabilities probably occur in many astrophysical situations. Two such problems, the interaction of the cosmic rays and the galactic magnetic field and the structure of radio galaxies, are discussed briefly. In some cases a magnetic field may inhibit an instability which occurs in its absence, and a discussion is also given of the possible suppression of convection by a magnetic field. (auth)

Cosmic Radiation

Refer also to abstracts 18569, 18656, 18803, 18818, 18819, 18823, and 18875.

18487 (AECL–4079) COSMIC RAY IGY NEUTRON MONITOR DATA. I. Monthly Graphs, January 1958–December 1958. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Dec 1971. 50p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

Uncorrected and barometer-corrected hourly rates from Deep River are given in tabular form for the period from January 1958 to December 1958. The barometer-corrected data were normalized to remove the effects of changes of efficiency and are compatible with the results of the 48-NM-64 monitor. Graphs of the corrected data are given. (auth)

18488 (HASL–248) COSMIC RADIATION IN THE ATMOSPHERE, 1969–1970. O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan 1972. 26p. Dep. NTIS.

Calculations of charged-particle intensities in the atmosphere were carried out and compared with the balloon-flight measurements of ionization and charged-particle flux of Lowder et al. Except near the top of the atmosphere (<100 g/cm^2), discrepancies were less than 20%. The discrepancies near the top of the atmosphere were associated with the use of the "straight-ahead" approximation and approximations in the treatment of the electromagnetic cascade. Calculations of the sea-level total charged-particle flux, the hard component of the charged-particle flux, and the vertical muon flux at 1 GeV/c were in close agreement with values reported by Rossi. It is shown that each of these flux values implies the same value (within 1%) of the sea-level cosmic-ray ionization, 2.02 ± 0.02 I, in agreement, when solar effects are taken into account, with Lowder and Beck and Shamos and Liboff who report 2.1 ± 0.1 I and 2.18 ± 0.05 I, near 55° geomagnetic latitude. Fluxes and spectra associated with these calculations are presented and their accuracies assessed. (auth)

18489 THERMODYNAMIC MODELS IN COSMOCHEMICAL SYSTEMS. Griffiths, P. R.; Brown, C. W.; Lippincott, E. R.; Dayhoff, M. O. (Georgetown Univ., Washington, D. C.). Geochim. Cosmochim. Acta; 36: No. 2, 109-28(Feb 1972).

Generalized computer methods are developed for inferring details of the formation of cosmochemical systems. Compositions of ideal gas mixtures existing in equilibrium with multicomponent solid and liquid phases are calculated. A comparison of computed results with experimental data is made for the ternary system MgO–FeO–SiO_2. While the ideal-solution approximation is shown to be inaccurate in dealing with the silicate melts, in a system where there are only solids and gas, the stable phases and compositions can be accurately calculated. A model system containing the elements H, O, Si, Mg, S, C, Cl, and F is investigated over a range of compositions involving the gas and ten solid phases, to show the power of the technique in dealing with complex gas–solid equilibria. Systems close to cosmic composition are considered, both with and without iron. When present, most of the iron is computed to be in the metallic state with little going into pyroxene or olivine solid solutions. At low hydrogen concentration and low temperature, troilite becomes the stable iron-bearing phase. The calculated equilibrium concentrations are very sensitive to the assumed ratio of magnesium to silicon. The computational method described is easily applied to complex systems of solids and gases and represents an important tool with which to investigate cosmochemical systems. (auth)

18490 RARE-EARTH ELEMENT DISTRIBUTION AND K/Rb RATIOS IN GRANULITES, MANGERITES, AND ANORTHOSITES, LOFOTEN–VESTERAALEN, NORWAY. Green, T. H.; Brunfelt, A. O.; Heier, K. S. (Mineralogical-Geological Museum, Oslo). Geochim. Cosmochim. Acta; 36: No. 2, 241-57(Feb 1972).

Neutron activation analysis for La, Ce, Nd, Sm, Eu, Gd, Tb, Yb and Lu, and x-ray fluorescence determination of K/Rb ratios were carried out on a suite of anorthosites, gabbros, mangerites, granulite facies gneisses, and amphibolite facies gneisses, selected from three separate anorthosite intrusions and their associated country rocks in the Precambrian Lofoten–Versteraalen high-grade metamorphic terrain. All samples except one show an enriched, linear fractionated rare-earth distribution relative to chondrites. The anorthosites, gabbros and mangerites have a conspicuous positive Eu anomaly but most of the granulite facies gneisses have normal Eu values. The K/Rb ratios are >2000 for the anorthosites and gneisses in the immediate contact zone and are between 500 and 1400 for the mangerites, compared with 200 to 500 for dioritic–monzonitic granulite facies gneisses distant from the anorthosite. Separate, small gabbro intrusions have K/Rb ratios of 200 to 800. The REE and K/Rb data suggest that the anorthosites and the major mangerite intrusions are not genetically related. The small Moskenesöy anorthosite may have been produced by melting in the dioritic gneisses, yielding monzonitic veins and dykes and an anorthositic residuum. The presence of a Eu anomaly in the K-feldspar-rich mangerites and the high K/Rb ratios for these rocks supports a two-stage melting mechanism for their generation in the deep crust. Later retrogression and complete recrystallization of the mangerites has not affected the rare-earth element distribution or the K/Rb ratios. Also, the amphibolite facies gneisses have similar rare-earth element distribution to granulite facies gneisses. (auth)

18491 OXYGEN ISOTOPE TEMPERATURES OF EQUILIBRATED ORDINARY CHONDRITES. Onuma, Naoki; Clayton, Robert N.; Mayeda, Toshiko K. (Univ. of Chicago). Geochim. Cosmochim. Acta; 36: No. 2, 157-68(Feb 1972).

Measurements were made of $^{18}O/^{16}O$ ratios of coexisting minerals (plagioclase, pyroxene, olivine) from nine ordinary chondrites. The ^{18}O content of a given mineral increases systematically from H through L to LL group. For example, mean $\delta^{18}O$ for olivine is 3.7‰ for H group, 4.1‰ for L group, and 4.3‰ for

LL group. Isotope fractionations for mineral pairs fall on a concordancy line, suggesting that these minerals were crystallized in oxygen isotope equilibrium. The isotopic temperature is estimated to be 950 ± 100°C for seven of the type 5 and type 6 chondrites, while Shaw (L6) has a higher temperature (1300°C), and Bjurböle (L4) has a lower temperature (690°C). These temperatures probably represent the maxima attained during dry thermal metamorphism. (auth)

18492 OXYGEN ISOTOPE COSMOTHERMOMETER. Onuma, Naoki; Clayton, Robert N.; Mayeda, Toshiko K. (Univ. of Chicago). Geochim. Cosmochim. Acta; 36: No. 2, 169-88(Feb 1972).

Variations in oxygen isotopic abundances of meteoritic minerals, chondrules, whole meteorites, and planets are discussed in terms of a model involving isotopic exchange between primordial dust and a cooling solar nebular gas. From the temperature dependence of the isotopic fractionation factors, temperatures are assigned to the processes of initial condensation, chondrule formation, and planetary accretion. Separated phases from carbonaceous chondrites fall into three isotopic groups representing widely differing conditions of formation: (a) low-iron olivine and pyroxene, and calcium–aluminum silicates condensed at temperatures >1000°K; (b) high-iron olivine and pyroxene melted to form chondrules after prior cooling and exchange to temperatures of 530 to 620°K; (c) hydrous silicates condensed at temperatures below 400°K. The ordinary chondrites, the Earth, and the Moon have remarkably similar isotopic compositions, which are not readily accounted for in terms of mixtures of known materials of the primitive meteorites. Mean accretion temperatures of 450 to 470°K are estimated for members of this group. The model permits an estimate of the $^{18}O/^{16}O$ ratio of the solar nebular gas, which gives $\delta^{18}O = -1 \pm 2‰$ relative to SMOW. (auth)

18493 RELATIVISTIC QUASILINEAR THEORY OF PARTICLE ACCELERATION BY HYDROMAGNETIC TURBULENCE. Kulsrud, Russell M. (Princeton Univ., N. J.); Ferrari, Attilio. Astrophys. Space Sci.; 12: No. 2, 302-18(Aug 1971).

The quasi-linear theory of acceleration of relativistic particles by hydromagnetic turbulence is treated in the adiabatic limit of small gyration radius. The theory is based on the relativistic Vlasov equation; however, a given pitch-angle scattering rate by microturbulence is postulated and is added to this equation. The resulting acceleration is found to be given by a diffusion coefficient in total momentum, which is proportional to the spectrum of turbulence with a rate coefficient γ (γ is a frequency that represents the efficiency of each wave component of the turbulence in producing acceleration). It is given as an integral over the solution of a differential equation in pitch angle. γ is evaluated in various limiting cases and is shown to lead to familiar forms of acceleration, such as Fermi acceleration and magnetic pumping. Thus, a comprehensive theory of these forms of heating is achieved. (auth)

18494 FORBUSH DECREASES IN THE FLUX OF GALACTIC COSMIC RAYS AND ASSOCIATED VLF NIGHT-TIME PROPAGATION PHENOMENA. Ananthakrishnan, S.; Hackradt, B. (Univ. Mackenzie, Sao Paulo, Brazil). Planet. Space Sci.; 20: No. 1, 81-7(Jan 1972).

Cosmic-ray Forbush decreases observed during the events of July 7th, 1966, May 23rd, 1967, and June 9th, 1969 produced night-time phase and amplitude perturbations on very low-frequency signals received at São Paulo, Brazil from transmitters GBZ, Criggion, U.K. (19.6 kHz), NBA, Balboa, Canal Zone (24.0 kHz), GBR, Rugby, U.K. (16.0 kHz) and NAA, Cutler, Maine, U.S.A. (17.8 kHz). All the above propagation paths to São Paulo are trans-equatorial and cross the South Atlantic geomagnetic anomaly. The effect of each event is discussed individually and reasons are advanced to account for the fact that even comparatively low-latitude paths crossing the anomaly can at times be affected by decreases in the cosmic ray flux. (auth)

18495 MUON BUNDLES IN LARGE EAS. Blake, P. R.; Ferguson, H.; Nash, W. F. (Univ. of Nottingham, Eng.). J. Phys., A (London); 5: No. 1, 125-31(Jan 1972).

The Nottingham muon detector at Haverah Park showed events that contained an unexpected close grouping of muons at large distances from the cores of extensive air showers (EAS). A detailed analysis of these events is given. The results are considered in relation to similar groupings observed near the core of showers by the Moscow State University group. (auth)

18496 COSMIC RAYS AND INTERSTELLAR MATTER. Kahn, F. D. (Univ. of Manchester, Eng.). Quart. J. Roy. Astron. Soc.; 12: No. 4, 384-401(Dec 1971).

Reference is made to Rickett's papers (1970) in which observations of twinkling of the radiation from the pulsars CP 0328 and NP 0531 are described; this is interpreted as due to fluctuations of the electron density in interstellar space, leading to corresponding fluctuations in refractive index. The present author argues that these fluctuations arise during the passage of Alfvén waves through the thermal plasma in interstellar space; these waves can be excited when the cosmic-ray plasma and the thermal plasma drift with respect to one another. When the Alfvén waves are excited they couple the cosmic-ray plasma to the interstellar gas and, hence, the energy content of the cosmic-ray plasma is available to drive the motions of the interstellar gas. This mechanism seems to be a promising means of setting up the motions observed in interstellar space. Topics discussed include the following: deductions from pulsar observations; properties of Alfvén waves; interactions of cosmic-ray plasma and thermal plasma; and cosmic-ray-assisted ionization fronts. (UK)

18497 SPECTRUM OF γ QUANTA RECORDED BY A GEIGER COUNTER IN DEEP SPACE. Dement'eva, N. N. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 3, 438-40(May–Jun 1971).

Translated from Kosm. Issled.; 9: No. 3, 477-9(May-Jun 1971).

The anti-coincidence scintillation detector aboard Venera-5 and Venera-6 spacecraft is described. Data on the intensities of background particle flux from the uv radiation counter and of the intensity of charged-particle flux during the flight are used to calculate approximate values of the intensities of background x-ray and γ-ray quanta, primary and secondary, recorded by the Geiger counter. The several processes occurring when charged particles pass through the material of the spacecraft body lead to the formation of γ quanta in the energy range 0.03 to 1.2 MeV. Processes forming γ quanta of these energies are, firstly, electron bremsstrahlung, and secondly, γ radiation arising from Coulomb excitation of the nucleus by protons and α particles. Also taken into account are γ radiation from nuclei, products of nuclear reactions, and in the proton energy range 30 MeV $\leq E_p \leq$ 200 MeV, electron bremsstrahlung from δ electrons, formed upon ionization of atoms by protons, i.e., the process $p \rightarrow e_\delta \rightarrow \gamma$. (J.C.W.)

18498 IDEALIZED MODEL FOR THE RADIAL GRADIENT OF MODULATED COSMIC RAYS. O'Gallagher, J. J. (Univ. of Maryland, College Park). J. Geophys. Res.; 77: No. 4, 513-23 (1 Feb 1972).

When the competing processes affecting cosmic rays in the interplanetary medium are studied, in the limit that deceleration and convection effects become comparable, the magnitude of the radial gradient of the density is essentially undefined with respect to local interplanetary characteristics (i.e., diffusion coefficient, solar-wind velocity). To provide a basis for interpreting existing and future gradient measurements in energy ranges where this limit may be appropriate, a simple conceptually idealized model is presented. The model assumes that the modulated spectrum consists of two idealized regions: (a) at low energy below some critical transition energy T_c where the shape of the spectrum is assumed to be determined wholly by a balance between convection and deceleration effects, and (b) at higher energies above T_c where the magnitude and shape of the spectrum are taken to be those given by the usual convection–diffusion modulation. The application of this model, invoking some straightforward assumptions about the behavior of the transition energy T_c, suggests that the radial gradient in the regime where deceleration processes are dominant may be related to the spectral index of the unmodulated spectrum at the transition energy T_c and to the absolute level of modulation. This is in contrast to the gradient at high energies above $T = T_c$, which is related only to local interplanetary characteristics through convection and diffusion. The predictions of this model are compared with the existing measurements of the differential gradient and are found to be consistent within a broad range of uncertainty based on estimates of the spectral index of the low-energy interstellar spectrum and the approximate level of modulation at solar minimum. 32 references. (auth)

Stars

Refer also to abstracts 18556, 18976, 19102, and 19177.

18499 SCALE OF EFFECTIVE TEMPERATURES AND BOLOMETRIC CORRECTIONS. Kubiak, Marcin (Univ., Warsaw). Postepy Astron.; 19: No. 4, 285-98(Dec 1971). (In Polish).

A short historical review is given of the earlier attempts to establish the scales of effective temperatures and bolometric corrections for the stars. The effective temperatures obtained

for B-type stars from the spectrometric observations and the revised effective temperatures scale based on the interferometric observations by Hanbury Brown et al. are given. (auth)

18500 PHYSICAL CHARACTERISTICS OF TYPE I SUPERNOVA ENVOLOPES DURING THE INITIAL EXPANSION PHASE. I. THERMAL PARAMETERS OF THE ENVELOPES AND AN ESTIMATE FOR THE NUMBER OF ABSORBING ATOMS. Mustel, E. R. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 527-35(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 665-75(Jul-Aug 1971).

The problem of the temperature of type-I supernova envelopes near maximum light is discussed. Spectrophotometric material as well as Pskovskii's B − V and U − B indices are taken into account. It is concluded that type-I supernova envelopes emit mainly thermal radiation near maximum light. At the epoch t_m of maximum, supernovae have a temperature between 15,000 and 10,000°K, corresponding to a radius for the "photosphere" of the envelope between 14,000 and 25,000 $R_\odot$ if $M_{ph} = -19.0$ m. Some important differences between type I supernovae and novae are discussed. In view of the absence of hydrogen lines from the spectra of these stars, the coefficient $\varkappa_\lambda$ would be expected to be relatively small inside the envelopes, and would be determined primarily by metal atoms (ions); $\varkappa_\lambda$ should increase toward shorter wavelengths. The small value of $\varkappa_\lambda$ and the large mass of the envelopes are the main reasons why the absorption lines in type I supernova spectra are so broad. The blend of the $D_{1,2}$ absorption lines of Na I was used to compute the number of sodium atoms in the envelope of the 1960 supernova in NGC 4496. A determination of the total mass of the envelope was hindered by ignorance of the relative hydrogen abundance in envelopes (no absorption or emission lines of this element are present) and of the abundance of such elements as He, C, N, and O. Nevertheless, calculations suggested the possibility of an enhanced heavy-element abundance in the envelope. (auth)

18501 ORIGIN OF THE OUTBURSTS OF U GEMINORUM STARS. Gorbatskii, V. G. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 536-41(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 676-83(Jul-Aug 1971).

A hypothesis is proposed to explain the origin of the energy released in outbursts of U Gem stars. The output of the energy sources in the interior of a U Gem star is assumed constant. This energy periodically accumulates in the outer regions of the star. A flare is observed when the stored energy emerges at the stellar surface. Such a behavior can account for the observations, in particular for the correlation between the flare amplitude and the length of the preceding cycle. Unstable convection in the envelope of a star belonging to a close binary system is suggested as a possible energy-storage mechanism. The cycle duration is estimated theoretically on this basis; the value calculated for the interval between outbursts is consistent with the observed values. (auth)

18502 COLLAPSE OF ROTATING STARS. Guseinov, O. Kh.; Kasumov, F. K. (Shemakha Astrophysical Observatory, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 570-2(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 722-5(Jul-Aug 1971).

The problem of mass loss by a rotating star in the course of collapse is considered. Assuming that the specific angular momentum of the material in the star is conserved from the time of onset of collapse, a value of 0.1 of the stellar mass is estimated for the maximum mass ejected by the star during collapse due to rotational instability alone. (auth)

18503 EMISSION OF MAGNETOSONIC WAVES BY PLANETS AND BINARY STARS REVOLVING IN CIRCULAR ORBITS. Dokuchaev, V. P. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 573-5(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 726-9(Jul-Aug 1971).

An analysis was made of the magnetosonic waves emitted when planets and stars move through space in circular orbits. The disturbances in the interstellar gas density in the wave zone of the sources were determined. The emission spectrum is shown to comprise frequencies that are multiples of the orbital revolution frequency of the sources. Estimates are given for the power of this radiation emitted by planets and binary stars. (auth)

18504 NEW EMISSION OBJECTS NEAR α = 17h 56m, δ = −22°40′. Arkhipova, V. P.; Dokuchaeva, O. D. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 593-6 (Jan−Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 752-4(Jul−Aug 1971).

Seventeen new objects showing Hα in emission have been discovered in a field measuring 4.5 × 4.5 centered at α = 17h56m, δ = −22°40′. The positions of the objects as well as identification charts are given. The appearance of the Hα line is described for 19 previously known emission stars in this region. (auth)

18505 HOT STARS WITH EXCESS REDDENING IN THE CLUSTER NGC 6913. Raznik, R. M. Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 597-600(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 755-9(Jul-Aug 1971).

Spectroscopic (dispersion 33 Å/mm) and photoelectric observations were made of 8 to 9m O9−B1 stars in the cluster NGC 6913. The determinations of the spectrum (MK system), M_V, $W_{H\gamma}$, V_r, W_{CaIIK}, V_{CaIIK}, ΔV, and ΔE_{B-V} were compared with other estimates. Variations were found in the brightness ΔV of the emission star No. 5 and in the radial velocity V_r of the suspected binary star No. 3, as well as increases in the equivalent width W_{CaIIK} and radial velocity V_{CaIIK} derived from the spectrum of star No. 4 (type O9.5 III). Variations in the color excesses ΔE_{B-V} of these stars are responsible for the characteristic bend in the (ΔE_{B-V}, Sp) curve described previously. (auth)

18506 DISTRIBUTION OF RED GIANTS IN THE GLOBULAR CLUSTER M92. Kadla, Z. I. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 601-5(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 760-5(Jul-Aug 1971).

A series of plates of several globular clusters were obtained with the 26-inch Pulkovo refractor in order to identify bright red giants belonging to the clusters and to examine possible correlations with other cluster characteristics. This investigation was restricted to M92. Sixty-seven members brighter than 13.40 mV were found on the basis of V magnitudes and proper motions. All these bright red giants are within 5.9′ of the cluster center; 34 of them are within 38.5″ of the center. (auth)

18507 ORBITAL ELEMENTS OF BETA LYRAE. Skul'skii, M. Yu. (Lvov State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 606-15(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 766-76(Jul-Aug 1971).

The λ 3933.7 Ca II line belonging to the secondary component of β Lyr was detected. Its radial-velocity curve had a semi-amplitude of 110 km/sec. Orbital elements, masses, and radii were derived for both components. $M_1 \sin^3 i = 12.9\ M_\odot$, $M_2 \sin^3 i = 21.7\ M_\odot$, $a_1 \sin i = 33 \times 10^6$ km, $a_2 \sin i = 19.6 \times 10^6$ km. The variation in the system velocity γ is suspected of being periodic. The third body in the triple system β Lyr had a mass of 2.5 $M_\odot$. (auth)

18508 RADIATION TRANSPORT WITH RAYLEIGH SCATTERING. II. FINITE ATMOSPHERE. Domke, H. (Central Inst. of Astrophysics, Potsdam, Ger.). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 616-23(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 777-89(Jul-Aug 1971).

The equation of transfer for polarized radiation in a plane-parallel atmosphere of finite optical thickness with conservative Rayleigh scattering and an arbitrary distribution of primary sources is reduced to scalar integral equations with displacement kernels. The four constants appearing in the equations are expressed in terms of the intensity of the emergent radiation. The problem of diffuse reflection and transmission is solved as a particular case. (auth)

18509 POSSIBLE EXISTENCE OF DISTANT COMPANIONS OF STARS. Antonov, V. A.; Latyshev, I. N. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 676-81 (Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 854-61(Jul-Aug 1971).

An estimate is obtained for the maximum distances such that the motion of a particle relative to the Sun (or another star) will be stable in the sense of Hill in the regular galactic force field. An equation for the corresponding zero-velocity surface is derived, allowing for the distinction of the galactic potential from that of a point mass. In the case of the Sun, the volume bounded by this surface is 3.35 pc^3; its greatest extent toward the galactic center and anticenter is 1.422 pc. Statistical surveys of wide pairs are consistent with the present results. (auth)

18510 POWER SPECTRUM ANALYSIS OF THE LIGHT CURVE OF RR TAURI. Silverman, S. M.; Ward, F. W. Jr.; Shapiro, R. (Air Force Cambridge Research Labs., Bedford, Mass.). Astrophys. Space Sci.; 12: No. 2, 319-24(Aug 1971).

Power spectrum analysis was applied to the light curve of RR Tauri. Periodicities were found at 80, 200, and 533 days with some variation in the peak positions and power for different decades. Factors involved in the classification of the variable are discussed. (auth)

18511 NEUTRINO EMISSION, POPULATION II STARS, AND BIG-BANG COSMOLOGY. Chaudhuri, Probhas Ray (Indian Statistical Inst., Calcutta). Astrophys. Space Sci.; 12: No. 2, 325-8(Aug 1971).

The spectroscopic determination of the helium abundance in the oldest stars of the Galaxy is supported by the theory of stellar evolution when neutrino emission is considered according to the photon–neutrino coupling theory, if it is assumed that the Population II stars started their life with a low surface-helium content. (auth)

18512 BERNOULLI'S INTEGRAL PERTAINING TO GAS FLOW IN CLOSE BINARY SYSTEMS. Sobouti, Yousef (Arya-Mehr Univ. of Tech., Teheran). Astrophys. Space Sci.; 12: No. 2, 408-10(Aug 1971).

A Bernoulli's integral supplemented with the equation of continuity provides a solution for the motion of gas surrounding a binary system. There exist two velocity modes whose streamlines are confined within appropriate equipotential surfaces. (auth)

18513 EFFECT OF A POLOIDAL MAGNETIC FIELD ON THE RADIAL AND NONRADIAL OSCILLATIONS OF A GASEOUS MASS. Fahlman, G. G. (Cambridge Univ., Eng.). Astrophys. Space Sci.; 12: No. 2, 424-55(Aug 1971).

The oscillations of a polytrope with infinite electric conductivity containing a weak internal poloidal magnetic field, which is continuous with an external dipole field, were examined with the aid of a variational equation. The corrections to the fundamental characteristic frequencies of the radial and nonradial l = 2 pulsation modes were calculated. The magnetic field removes a degeneracy that occurs between these two modes and the resulting frequency splitting was evaluated. The relevance of the results to the known magnetic stars is briefly discussed. (auth)

18514 NEUTRINO BREMSSTRAHLUNG FROM A DEGENERATE ELECTRON GAS. Saha, Sushen Kumar. Astrophys. Space Sci.; 12: No. 2, 493-500(Aug 1971).

The neutrino bremsstrahlung process is studied according to the photon–neutrino weak-coupling theory by considering the electrons as relativistic and degenerate and by adding some lattice effects at high density. The neutrino energy loss rate due to the process is then compared with that obtained according to the current–current coupling theory. It is concluded that the process is important only in cases of high-density stars when the temperature is below 10^7K. (auth)

18515 PROBLEMS AND ACHIEVEMENTS OF NUCLEAR ASTROPHYSICS. PART II. NUCLEOSYNTHESIS OF CHEMICAL ELEMENTS AS THE RESULT OF ENERGY PRODUCTION IN STARS. Kuchowicz, Bronislaw (Univ., Warsaw). Postepy Fiz.; 22: No. 6, 601-22(1971). (In Polish).

The problem of stellar evolution is considered from the standpoint of energy sources and nucleosynthesis of chemical elements. The major nuclear burning stages in stellar evolution are considered: hydrogen burning (especially the p–p cycle), helium burning, and advanced burning stages, finally the question of nuclear statistical equilibrium in stellar matter and its relation to the e process. The following processes of nucleosynthesis are surveyed: the production of helium, carbon, oxygen, and other α-type nuclei, also the production of the nuclei from the iron peak in the e process. In all the processes under consideration, the production of new nuclear species may be regarded to be a by-product of energy generation. (auth)

18516 MODELS FOR SUPERMASSIVE STARS. Anttila, E. (Helsinki Univ. of Tech., Otaniemi, Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 374, 1-44(1971).

Thesis.

It is shown that the solutions of the static field equations of general relativity can be divided into two main types. In the first type, both pressure and density vanish at the surface. In the second type, pressure vanishes but not the density. Thus, stars of this type have a halo surrounding them. It consists of free gas particles circulating the main body of the star under the influence of gravitation only. The density of the halo is proportional to the relativity parameter σ. In type 1, $\sigma < 0.4$. The solutions of the second type can further be divided into four subtypes: type 2, $0 \leq \sigma \leq 0.7976\ldots$, type 3 and type 4, $\sigma \leq 0.0577\ldots$, type 5, $\frac{2}{3} \leq \sigma \leq 0.7976\ldots$ Several supermassive star models were calculated, using different polytropic equations as equations of state in order to search for common features that are independent of the equation of state used. Such features are the behavior of tensor components, and that of density distribution both of which depend on the relativity parameter. The equations of state used in the integration of the field equations change the number of types and their limits. Binding energy is negative, in general. (auth) (Finland)

18517 THEORY OF MAGNETIC STARS. Mestel, L. (Univ. of Manchester, Eng.). Quart. J. Roy. Astron. Soc.; 12: No. 4, 402-16(Dec 1971).

The subject is discussed under the following headings: star formation and the galactic magnetic field; flux loss; the Hayashi phase; the observed magnetic stars; relation between internal and surface fields in magnetic stars; rotations of A_p stars; and the origin of the large obliquity. (UK)

18518 ROTATIONALLY EXTENDED STELLAR ENVELOPES. IV. THE DETACHED SHELL OF HD 187399. Hutchings, J. B.; Laskarides, P. G. (Dominion Astrophysical Observatory, Victoria, B. C.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 357-71(1972).

Spectrographic observations were obtained at 6.5 Å mm^{-1} of the shell star HD 187399 before, during, and after an outburst, in June and July 1970. Velocity and line profile measurements are presented. A model for the stellar envelope is deduced from these data and calculations of stellar and shell line profiles. The shell and line of sight lie near the equatorial plane and the shell probably consists of one or more discrete rings of matter. Most of the mass of each ring does not return to the stellar surface and the shell is thought to be replenished by fairly frequent outbursts of the type observed. (auth)

18519 ORIGIN OF THE Am PHENOMENON. Stickland, D. J.; Whelan, J. A. J. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 11P-15P(1972).

New model-stellar-envelope calculations are combined with the element separation hypothesis to account for the appearance of the metallic-line stars, their position on the H–R diagram, and their absence among rapidly rotating stars. (auth)

18520 SPECTRUM OF OMICRON VIRGINIS. Williams, P. M. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 17P-19P(1972).

From an analysis relative to ε Vir using 20 Å mm^{-1} spectrograms, o Vir is found to be generally metal-poor, but overabundant in heavy metals. Unlike the Ba II and CH stars, however, o Vir appears to be anomalously rich in oxygen. (auth)

18521 REVERSIBLE TRANSFORMATIONS OF A CHARGED BLACK HOLE. Christodoulou, Demetrios; Ruffini, Remo (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 12, 3552-5(15 Dec 1971).

A formula was derived for the mass of a black hole as a function of its "irreducible mass," its angular momentum, and its charge. It is shown that 50% of the mass of an extreme charged black hole can be converted into energy as contrasted with 29% for an extreme rotating black hole. (auth)

18522 EXCITATION OF C III IN WOLF–RAYET ENVELOPES. Castor, John I. (Univ. of Colorado, Boulder); Nussbaumer, H. Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 293-304(1972).

The model of a spherically expanding envelope is employed to find equivalent widths of C III lines in the rocket ultraviolet. The calculations include electron–ion collisions, and absorptions and emissions associated with the stellar and diffuse radiation fields. Effects of optical depth are taken into account by calculating photon escape probabilities. It is found that the envelope of γ^2 Vel, WC8 + O8, has an electron temperature of 20,000 to 25,000°K, and electron density of about 4×10^{11} cm^{-3}. For the ratio of carbon density to electron density it is found that $N_c/N_e \geq 2.5 \times 10^{-3}$. The calculations allow for laser action, but in no case does that process occur. (auth)

18523 EFFECT OF RAPID ROTATION ON RADIATION FROM STARS. IV. WEAK ABSORPTION LINES AND SPECTRAL TYPES. Hardorp, J. (State Univ. of New York, Stony Brook); Strittmatter, P. A. Astron. Astrophys.; 17: No. 2, 161-4(Mar 1972).

The effect of rapid rigid rotation on weak- and intermediate-strength lines in early-type spectra is investigated. Since these lines will be discernible only in sharp-lined stars, the discussion is confined in the main to the pole-on case. It is shown that for such stars (a) rotation alone has a negligible effect on abundance determinations based on lines with equivalent widths in the range 25 to 150 mÅ; (b) rotation does not provide an explanation for the excessive strength of Si-III lines in early B stars; and (c) the relation between spectral type and color index (b – y) is essentially unchanged by rotation. (auth)

18524 STUDY OF H_α AND [N II] PROFILES AND RATIOS IN M8 AND M42. Dopita, M. A. (Univ. of Manchester, Eng.). Astron. Astrophys.; 17: No. 2, 165-71(Mar 1972).

A photoelectric Fabry–Perot was used to make measurements of the profiles of the H_α and [N II] emission lines of the diffuse nebulae M8 and M42. These results are more accurate than any previously obtained. Temperatures and turbulent motions of these nebulae were then determined. The H_α/[N II] brightness ratios

were found for 10 positions across the bright core of M8. A lower limit for the abundance of nitrogen was obtained. (auth)

18525 OBSERVED EFFECTS OF GRAVITY DARKENING IN ROTATING B STARS. Norris, John; Scholz, M. (Univ., Heidelberg). Astron. Astrophys.; 17: No. 2, 182-9(Mar 1972).

Predictions of Hardorp and Scholz (1971) cnncerning the behavior of He I λ4471 and Mg II λ4481 in the spectra of rapidly rotating B stars were confirmed by new observations. In early B stars of a given Balmer discontinuity, the equivalent width of He I λ4471 is systematically larger in sharp-lined than in broad-lined stars (when corrections are applied for evolutionary effects). In late B stars, the difference between the projected rotational velocities derived according to Slettebak's (1949) method (i.e., neglecting gravity darkening) from Mg II λ4481 on the one hand and from He I λ4471 on the other, increases towards later spectral types. (auth)

18526 SECULAR STABILITY. III. THE SECULAR SPECTRUM OF STARS OF 2.5, 5, 10, AND 15 SOLAR MASSES. Aizenman, M. L.; Perdang, J. (Institut d'Astrophysique, Cointe-Ougree, Belgium). Astron. Astrophys.; 17: No. 2, 190-2(Mar 1972).

In an earlier paper (Paper I) the existence of complex roots in the secular spectrum of a star of 1.13 $M_\odot$ as it evolved away from the main sequence was reported. In this paper the results obtained for stars of 2.5, 5, 10, and 15 $M_\odot$ whose initial composition is identical to that of the 1.13 $M_\odot$ star (X = 0.75, Y = 0.22, Z = 0.03) are discussed. (auth)

18527 MEMBERSHIP OF THE OPEN CLUSTER IC 4665. Sanders, W. L.; van Altena, W. F. (Yerkes Observatory, Williams Bay, Wis.). Astron. Astrophys.; 17: No. 2, 193-200(Mar 1972).

Probabilities of membership, based on relative proper motions, for 275 stars in the field of IC 4665 are given. The cluster proper motion dispersion (m.e.) of 0.0009″ yields 19 probable members in the limited field studied (approx. 40′ × 50′). The main sequence is believed to terminate at $M_V \cong +3.5$, or F6V. (auth)

18528 SUDDEN CHANGES IN THE PERIOD OF THE ECLIPSING CONTACT BINARY 44i BOOTIS. Bergeat, J. (Observatoire, Lyon); Lunel, M.; Sibille, F.; van't Veer, F. Astron. Astrophys.; 17: No. 2, 215-19(Mar 1972).

From photoelectric observations of 44 i Boo obtained during the years 1969–1971, 23 determinations were made of the times of conjunction from the observed minima. A critical analysis of the data combined with those published by other observers led to the conclusion that this eclipsing system suffers periodic changes of the period. The general aspect of the light curve confirms the existence of active and quiet periods. The interval between sudden period changes is of the order of 10 years. (auth)

18529 GENERATION OF MAGNETIC FIELD IN ROTATING RELATIVISTIC OBJECTS. Bisnovatyi-Kogan, G. S.; Ruzmaikin, A. A. (Inst. of Applied Mathematics, Moscow). Astron. Astrophys.; 17: No. 2, 243-5(Mar 1972).

It is shown that there is no magnetic field generation in a stationary rotating relativistic star if Ω = const in the case of a barotropic medium and in an isentropic star with Ω ≠ const. (auth)

18530 NOTE ON THE GROWTH RATE OF CONVECTIVE MODES IN A SELF GRAVITATING GAS SPHERE. Grisvard, P.; Souffrin, P.; Zerner, M. (Faculte des Sciences, Nice. Observatoire, Nice). Astron. Astrophys.; 17: No. 2, 309-11(Mar 1972).

It is shown that, within Cowling's approximation, the growth rate of the eigenmodes in a convectively unstable self-gravitating gas sphere is a bounded monotonically increasing function of the degree of the harmonic. (auth)

18531 SYSTEM FOR PHOTOMETRIC THREE-DIMENSIONAL CLASSIFICATION OF STARS. Straizys, V.; Sviderskiene, Z. (Inst. of Physics and Mathematics, Vilnyus, USSR). Astron. Astrophys.; 17: No. 2, 312-22(Mar 1972).

The eight-color intermediate band photometric system is developed for purely photometric determination of spectral classes, absolute magnitudes, [Fe/H] ratios, and interstellar reddening of the stars. The two-dimensional classification is based on the reddening-free quantities Q calibrated in spectral classes and absolute magnitudes. The general scheme of three-dimensional classification of any collection of stars, including the samples of different temperatures, luminosities, populations, interstellar reddenings, and some kinds of peculiarities, is given. The errors of spectral class and M_V determinations are discussed. The interstellar reddening can be determined from the calibrated two-color diagrams when two-dimensional classification of stars is already made. (auth)

18532 NEW RED VARIABLE STAR IN CAMELOPARDALIS. Kazaryan, M.; Terzan, A. (Byurakan Astrophysical Observatory, Erevan, USSR). Astron. Astrophys.; 17: No. 2, 323-4(Mar 1972).

On the plates taken (with the prisms of 1.5 and 4°) with the Schmidt telescope at Byurakan Observatory, a new red long-period variable star was discovered. From the infrared and red spectra, it seems to be a M0 star. (auth)

18533 COMPARISON OF THE LARGE MAGELLANIC CLOUD CATALOGS OF SANDULEAK AND FEHRENBACH–DUFLOT. Sanduleak, N. (Case Western Reserve Univ., Cleveland). Astron. Astrophys.; 17: No. 2, 326-8(Mar 1972).

A comparison was made between the catalog of probable Large Magellanic Cloud member stars published by Sanduleak (1969) based on objective-prism spectroscopy and the corresponding catalog of Fehrenbach and Duflot (1970) in which radial velocities obtained from objective-prism plates were used to indicate membership. This results in the identification of probable high-velocity stars in the foreground of the LMC and a group of stars that might include horizontal-branch stars or possibly "bridge" stars located between our Galaxy and the Large Cloud. (auth)

18534 COMPOSITE MODELS IN GENERAL RELATIVITY. Hargreaves, J. C. (Royal Holloway Coll., Surrey, Eng.). J. Phys., A (London); 5: No. 2, 211-30(Feb 1972).

The stability of static spherically symmetrical fluid spheres, consisting of a core and an envelope, is investigated on the basis of general relativity. It is assumed that the core consists of ideal gas and radiation, in which the ratio β of the gas pressure to the total pressure is a small constant, and that the envelope consists of an adiabatic gas. Numerical analysis indicates that for a given $\sigma = p_c/\rho_{gc}c^2$ (the ratio of the central pressure to the central rest-energy density) the stability of such a sphere depends strongly on the position of the interface separating the core from the envelope, the sphere being stable for a greater range of values of σ the closer the interface is to the center. (auth)

18535 RADIO STARS BETA PERSEI AND BETA LYRAE. Wade, C. M.; Hjellming, R. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London); 235: No. 5336, 270-1(4 Feb 1972).

Detection of radio emission from the two well-known eclipsing binaries β Persei and β Lyrae is reported, using the NRAO interferometer operating at 2,695 and 8,085 MHz. The observations were made on Oct. 23 to Nov. 10, 1971. The positions of the point radio sources associated with the two stars are reported, together with the optical positions, the close coincidence between these leaving no doubt that the radio sources are associated with the stars. It was found that the radio emission of β Persei is strongly variable at 2,695 MHz, but variability at 8,085 MHz was less clearly established. It is not certain that β Lyrae is variable at these frequencies. Since the angular size of the radio emitting region in β Persei may be very small, it is possible that the variability could be due primarily to scintillations imposed by the interstellar medium. Mechanisms for the emission are discussed. It is concluded that the presence of probably nonthermal radio sources in β Persei and β Lyrae indicates that some unusual high-energy processes may be occurring in these systems. (UK)

18536 PHOTOELECTRIC OBSERVATIONS OF LY AURIGAE. Mayer, P.; Horak, T. B. (Charles Univ., Prague). Bull. Astron. Inst. Czech.; 22: No. 6, 327-33(1971).

UBV measurements of the eclipsing variable LY Aur are published. The eclipses are complete. New light elements are given, and a tentative solution is presented. (auth)

18537 ABSORPTION IN RING ENVELOPES. Sima, Z. (Charles Univ., Prague). Bull. Astron. Inst. Czech.; 22: No. 6, 334-42(1971).

Gaseous rings which rotate round the primary star in some close binary systems were proved on the basis of their emission lines. Here the profiles of the spectral lines due to the absorption in the rings are discussed. The computed profiles of lines are very wide but so very shallow that it is nearly impossible to observe them. The phenomenon is caused by great Doppler effect. The profiles are also computed for half eclipse case. They are deeper in some parts which causes the illusory shift of spectral lines. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 18934.

18538 (AD–731552) RADIO SOURCES: 3.3-MM FLUX AND VARIABILITY MEASUREMENTS. Report for April 1965–March 1971. Fogarty, William G.; Epstein, Eugene E.; Montgomery, John W.; Dworetsky, Michael M. (Aerospace Corp., El Segundo, Calif.). 15 Aug 1971. Contract F04701-71-C-0172. 32p. (SAMSO-TR-71-225). NTIS.

Graphical and tabular summaries of 3.3-mm (90-GHz) flux measurements of 35 discrete galactic and extragalactic sources are presented, including results of extensive monitoring of nine sources. Variability at 3.3-mm is certain for NGC 1068, NGC 1275, 3C 120, 3C 273, 3C 279, VRO 42.22.01, and 3C 454.3; repeated outbursts with time scales ranging from a week to several months were observed for all of these except NGC 1068 and 3C 454.3. (auth) (USGRDR)

18539 (N-72-10893) APOLLO GALACTIC X-RAY ASTRONOMY OBSERVATIONS. Adler, I.; Trombka, J.; Schmadebeck, R.; Gorenstein, P.; Bjorkholm, P. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct 1971. 11p. (NASA-TM-X-65725; X-641-71-420). NTIS.

The galactic x-ray observations are a detailed study of the temporal behavior of pulsating x-ray sources. NASA's first x-ray astronomy satellite Uhuru (Explorer 42) has recently discovered fast-time variability of pulsations in the output from several sources. The variability occurs on a time scale of minutes, seconds, or less, implying that the emitting regions are very small in size, much smaller than the Sun, although they are emitting about a thousand times more power. Fast-time variability may provide the clue that is needed to understand the mechanisms which drive pulsating sources. The Apollo observations record the emission from several objects continuously for a period of about an hour. The spacecraft can be pointed at the source for the entire time. On the other hand, Uhuru can observe only for about a minute or two per sighting. Consequently, Apollo has the capability for determining whether periodicities exist in the 10- to 1000-second range. (auth) (STAR)

18540 BEGINNINGS OF ORGANIC COSMOCHEMISTRY. Kuchowicz, Bronislaw (Univ., Warsaw). Postepy Astron.; 19: No. 4, 299-312(Dec 1971). (In Polish).

Though the study of stellar spectra and the determination of the abundances of elements in stellar atmospheres may deserve the name of cosmochemistry, until very recently only the cosmic counterpart of inorganic chemistry existed. Three years ago the application of radio telescopes to a search for molecular spectral lines from space started what may be now called organic cosmochemistry. Sixteen kinds of complex molecules are known to exist in the gas clouds of interstellar space. Sophisticated methods of laboratory investigations on Moon dust and meteorite matter provide additional tools for studying extraterrestrial chemical evolution. (auth)

18541 EXTRAGALACTIC SOURCES OF COSMIC RADIO WAVES. III. DOUBLE RADIO SOURCES. Kuril'chik, V. N. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 542-51(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 684-96(Jul-Aug 1971).

A discussion is given of the properties of the continuous radio-emission spectra of radio sources with double structure. An important feature in the spectra of individual components is the presence of a bend or "break" where the spectral index changes from an average value $\bar{\alpha}_S \approx 0.70$ to $\bar{\alpha}_L \approx 1.20$. The bends in the spectra of components belonging to the same source are usually displaced in frequency. It is unlikely that these bends in the component spectra result from synchrotron or Compton radiation losses by relativistic electrons within the components themselves, or that the frequency shift arises from a time evolution of the components. The observations also are inconsistent with the possibility of a Doppler origin for this shift. The parameters observed in double radio structures (displacement of the bend frequencies, components with nearly equal radio intensities at frequencies before the bend points, the positions of the components relative to the corresponding optical objects) conflict with the model of isotropically radiating components separating at relativistic velocity, and with the model of a simple adiabatic expansion of isotropically radiating components moving at a velocity $v \ll c$. A model of adiabatically expanding components (with $v \ll c$) receiving a continuous injection of new relativistic electrons appears to be more realistic. A qualitative examination is made of a model for a double radio structure involving anisotropic streams of relativistic electrons in a quasidipole magnetic-field configuration that would be formed from a dipole field around the nucleus of the object as the radio source evolves. Some observational implications of this model are discussed. (auth)

18542 ELECTRON ACCELERATION IN AN ALTERNATING MAGNETIC FIELD UNDER ASTROPHYSICAL CONDITIONS. Bakhareva, M. F.; Lomonosov, V. N.; Tverskoi, B. A. (Moscow State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 552-60(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 697-709(Jul-Aug 1971).

The steady-state problem of the energy spectrum of electrons accelerated in a periodically varying magnetic field (the Alfvén magnetic pumping mechanism) is solved, with the magnetobremsstrahlung (synchrotron radiation) of the electrons taken into account. The resulting energy spectrum is used to derive the frequency spectrum for the synchrotron radiation of the particles, and to establish a relation between the parameters of the spectrum and those of the variable field. The conditions such that cyclotron instability would provide the scattering needed for effective acceleration are applied to determine restrictions on the possible width of the frequency spectrum, the minimum fast-particle concentration, and the average magnetic-field strength for a given variability period T. It is shown that the synchrotron x rays of the Crab Nebula and of the pulsar located at the center of the nebula could be generated by this mechanism. Upper and lower bounds are set on the magnetic-field strength in the emission region of the Crab pulsar, and various parameters describing its x rays are calculated. (auth)

18543 INFLUENCE OF PLASMA INHOMOGENEITIES ON RADIO-WAVE ABSORPTION IN THE INTERSTELLAR MEDIUM. Tokarev, Yu. V. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 561-5(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 710-15(Jul-Aug 1971).

The absorption of radio waves in interstellar clouds of ionized hydrogen is discussed. With a finite antenna beamwidth, the equivalent optical depth for a layer composed of such clouds will increase considerably more slowly as the frequency decreases than for a homogeneous absorbing layer. An analysis is made of measurements of the cosmic radio-emission spectrum at frequencies below 10 MHz. (auth)

18544 INTERPRETATION OF NONLINEAR RADIO SPECTRA OF DISCRETE RADIO SOURCES BY A GENERAL MECHANISM. Braude, S. Ya.; Ryabov, B. P.; Zhouck, I. N. (Inst. of Radiophysics and Electronics, Kharkov). Astrophys. Space Sci.; 12: No. 2, 349-65(Aug 1971).

The analysis of discrete radio sources spectra in the range 10 to 5000-MHz reveals that deviations from a power law in the low-frequency region may be due to distortion of differential energy spectra of relativistic electrons at low energies. An empirical expression for an energy-spectrum law was found to be in a good agreement with most of the radio spectra measured. The main physical parameters of 92 sources are evaluated. It is concluded that a low-energy electron excess exists with respect to the law $E^{-\gamma}$ in most of the discrete sources which radiate nonlinear low-frequency spectra. (auth)

18545 TIME VARIATION OF THE X-RAY SPECTRUM AND OPTICAL LUMINOSITY OF SCO X-1. Kitamura, T. (Tokyo Univ.); Matsuoka, M.; Miyamoto, S.; (and others). Astrophys. Space Sci.; 12: No. 2, 378-93(Aug 1971).

Results of rocket observations of Sco X-1 over the spectral range of 2 ~ 20 keV are presented. The observations were performed partly in India and partly in Japan under the collaboration of the three groups. Results are compared with results of similar observations carried out by the LRL (Lawrence Radiation Laboratory) group. Some of these x-ray observations were accompanied by simultaneous optical observations. Relationships between the hardness of the x-ray spectrum and the x-ray intensity and between the hardness and the optical luminosity are compiled. The relationships among the parameters (temperature, density, and size) which characterize the postulated isothermal cloud model of Sco X-1 are given. They indicate that Sco X-1 is characterized by a temperature of about 10^7 to 10^8 K, a density of about 10^{16} to 10^{17} cm^{-3} and a radius of about 10^8 to 10^9 cm, respectively. It is further shown that the temperature is inversely correlated with the size of the source; an increase in temperature corresponds to a decrease in the radius and an increase in density. (auth)

18546 DOPPLER PERIOD VARIATIONS OF HIGH-VELOCITY PULSARS. Gallino, R.; Silvestro, G. (Univ., Turin. CNR, Turin). Astrophys. Space Sci.; 12: No. 2, 415-23(Aug 1971).

The effect of the source motion on the period variation of pulsars is investigated. For some pulsars, a velocity 100 to 300 km/s can give a Doppler contribution to the second period derivative $\ddot{P}$ which is comparable or larger than the intrinsic variation predicted by theoretical models, whereas larger velocities are required in order to give an appreciable kinematic effect on the first derivative $\dot{P}$. The possibility of experimental detection of $\ddot{P}$ and proper motion for known pulsars is discussed. (auth)

18547 BERKELEY SURVEY OF HIGH-VELOCITY INTERSTELLAR NEUTRAL HYDROGEN. 1. THE SECTION b = -15° TO +15°, l = 10° TO 250°. Dieter, N. H. (Univ. of California, Berkeley). Astron. Astrophys., Suppl. Ser.; 5: No. 1, 21-80(Jan 1972).

Results of a survey of high-velocity interstellar neutral hydrogen are presented in the form of contour diagrams of antenna temperature as functions of galactic latitude and velocity. This is the first of two sections to the survey and includes observations near the galactic plane. The second will include high-latitude observations. (auth)

18548 SYSTEMATIC SEARCH FOR HIGH-VELOCITY HYDROGEN OUTSIDE THE GALACTIC PLANE. I. Van Kuilenburg, J. (Leiden Observatory). Astron. Astrophys., Suppl. Ser.; 5: No. 1, 1-19(Jan 1972).

A survey is presented of neutral hydrogen with radial velocities between −270 and −60 km/s at positive declinations and radial velocities between +60 and +270 km/s at negative declinations. The drift scans on which the survey is based were separated by 2.5° in declination. The region $-15° < b^{II} < 15°$ is not included in this survey. (auth)

18549 PULSED X-RADIATION FROM THE CRAB NEBULA. Boclet, D.; Brucy, G.; Claisse, J.; Durouchoux, P.; Rocchia, R. (CEN, Gif-sur-Yvette, France). Nature (London) Phys. Sci.; 235: No. 56, 69-72(24 Jan 1972).

The final results of an analysis of the x-ray emission from the Crab Nebula in the 15- to 150-keV range are presented. The data were obtained from balloon flights on September 15 and 22, 1970, from Aire-sur-Adour, France. Details are given of the experimental technique and method of data analysis. It was established that the pulsed x radiation was 22.16 ± 2.54% of the total flux received in the 15- to 150-keV energy range, and the mean value for the apparent increase in the ratio of interpulse to main pulse energies for this energy range was 1.38 ± 0.16. The well-known double structure appeared prominently. Results on pulse structure obtained by various experimenters are summarized. The profile appears to vary with energy; at high energy the interpulse is as high as the main pulse, whereas the main pulse is higher at lower energies, and between the two pulses a small increase in hard x rays was shown. The width of the main pulse was 1.5 ± 0.5 ms and that of the interpulse was 4.5 ± 0.5 ms, with a pulse separation of 12.5 ± 0.5 ms, consistent with optical and soft x-ray observations. (UK)

18550 IDENTIFICATION OF GX 3 + 1 FROM LUNAR OCCULTATIONS. Janes, A. F. (Univ. of Leicester, Eng.); Pounds, K. A.; Ricketts, M. J.; Willmore, A. P.; Morrison, L. V. Nature (London); 235: No. 5334, 152-5(21 Jan 1972).

It is stated that the position of GX 3 + 1 has been reported with sufficient accuracy to allow the times of lunar occultations to be predicted to within about ±3 min, and a description is given of the observation of two lunar occultations predicted for the rocket range at Woomera, Australia, the first on Sept. 27, 1971 by the Leicester X-Ray Astronomy Group, and the second on Oct. 24, 1971 by the Mullard Space Science Laboratory, University College, London. For the observations a sideways-looking proportional detector was mounted on a sun-pointing Skylark rocket; the detector was argon−methane filled, with sensitivity 1 to 18 keV. (UK)

18551 NEW X-RAY PULSAR NEAR THE CRAB NEBULA. Sadeh, D. S. (Naval Research Lab., Washington, D. C. Univ. of Tel-Aviv, Israel); Meidav, M.; Smathers, H. W.; Chubb, T. A.; Friedman, H. Nature (London); 235: No. 5334, 151-2(21 Jan 1972).

Observation of what appears to be a new x-ray pulsar on Oct. 17, 1970 with a balloon-borne x-ray telescope launched from Palestine, Texas is described. The detector comprised three xenon-filled proportional counters, with a sensitivity of 30 to 100 keV. Power spectra and phase histograms are reproduced. From the data it may be concluded that the x-ray pulsation may be associated with the central star in the Crab Nebula, NP 0532, or with the other known radio pulsar near the Crab, NP 0527, or it may originate in a third pulsar in the vicinity of the Crab. Earlier data, however, gave no evidence of pulsation from NP 0532 or 0527. If further observations show that NP 0527 is an x-ray pulsar, however, it would appear that present models of x-ray pulsars must be revised. If the new source is not associated with NP 0527, it may be an object like Cen X-3, which may be a white dwarf near the limit of rotational instability. (UK)

18552 X-RAY ASTRONOMY: OBSERVATIONS OF NEW PHENOMENA. Metz, William D. Science; 175: No. 4020, 397-9(28 Jan 1972).

Recent developments in x-ray astronomy are discussed and results from the Uhuru satellite are considered in some detail. Topics considered include complex variations, proposed models, and extragalactic objects. (W.D.M.)

18553 RELATIVE ORIENTATION OF RADIO SOURCES. Willson, M. A. G. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 275-82(1972).

The relative orientation of the major axes of double radio sources is investigated. It is found that sources less than 10° apart tend to lie parallel to each other. The effect is particularly strong for the unidentified sources and is apparently unrelated to the alleged association of radio sources with Arp's (1966, 1967, 1968) peculiar galaxies. It supports the suggestion of Brown (1964, 1968) that galaxies are orientated nonrandomly on a scale of a few hundred megaparsecs. (auth)

18554 CONTINUUM RADIATIVE TRANSFER IN A HOT PLASMA, WITH APPLICATION TO SCORPIUS X-1. Felten, James E. (Inst. of Theoretical Astronomy, Cambridge, Eng. Tata Inst. of Fundamental Research, Bombay); Rees Martin J. Astron. Astrophys.; 17: No. 2, 226-42(Mar 1972).

Results from the theory of emitting atmospheres were used to derive the spectral shape of the continuum emerging from a homogeneous plasma cloud, which scatters the radiation coherently. The data on Sco X-1 is discussed, and the theoretical results are applied to obtain parameters for simple models of the source, emphasizing the limitations of this procedure. The extent to which the results can be generalized to asymmetric and inhomogeneous source models is discussed, and the modifications that occur when incoherence in the scatterings becomes important are indicated. (W.D.M.)

18555 BRIGHTNESS OF THE NEW QUASI-STELLAR SOURCE B 2 1215 + 30. Klare, G. (Landessternwarte, Heidelberg). Astron. Astrophys.; 17: No. 2, 325(Mar 1972).

The brightness of the quasi-stellar radio-source B2 1215 + 30 (= ON 325) is given for May 7, 1907. (auth)

18556 COINCIDENCE OF OH EMISSION SOURCES AND BRIGHT KNOTS IN H II REGIONS. Habing, H. J.; Israel, F. P.; de Jong, T. (Sterrewacht, Leiden). Astron. Astrophys.; 17: No. 2, 329-34(Mar 1972).

The H II region NGC 7538 is discussed on the basis of aperture synthesis observations at 1.415 GHz (21 cm continuum) with a resolution of 20″. The nebula consists of a shell of ionized gas and an associated point source of 0.85 flux units. The point source coincides to within 10″ with a class I OH emission source, of which an accurate position was recently determined by Hardebeck. Similar coincidences in other H II regions have been reported. A preliminary physical model is suggested in which the shell in NGC 7538 is produced by a young, first-generation, visible, early type star, while the point source is a newborn, second-generation star, invisible inside a dust cocoon. The OH emission originates in protostars near the point source. (auth)

18557 POLARIZATION PROPERTIES OF 65 EXTRAGALACTIC SOURCES IN THE 3C CATALOGUE. Mitton, Simon (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 373-81(1972).

A summary of the polarization properties of 65 sources in the 3C catalogue is presented, based on published material together with newly determined rotation measures. A discussion of the data shows that the source axes and magnetic field directions are related, but reveals no obvious correlations between the physical parameters of sources and their polarization properties. The relation of polarization properties to models of radio sources is discussed, and restrictions can be placed on the magnetic fields and thermal electron densities in these sources. (auth)

18558 DECREASE OF FLUX DENSITY OF CASSIOPEIA A AND THE ABSOLUTE SPECTRA OF CASSIOPEIA A, CYGNUS A AND TAURUS A. Baars, J. W. M. (Dwingeloo Radio Observatory, Netherlands); Hartsuijker, A. P. Astron. Astrophys.; 17: No. 2, 172-81(Mar 1972).

Recent accurate observations of Cassiopeia A relative to Cygnus A and Taurus A at 1.4 and 3 GHz were compared with older measurements of the same sources with similar telescopes (25m diameter paraboloids). At both frequencies a secular decrease in the flux density of Cas A of 0.90 ± 0.10% per year was found. This was lower than a recently published value of 1.29 ± 0.08% per year at 81.5 MHz, thus indicating a possible dependence of the secular rate on frequency. A new analysis is presented of the absolute spectrum of Cassiopeia, using all absolute measurements up to 1971. The spectrum leads to significant differences with currently used flux density scales at frequencies below 500 MHz. Good agreement was found with a new scale established by Wyllie from absolute observations of weaker sources. The spectral index was −0.787 and S = 3185 f.u. (1965.0) at 1 GHz. The spectra of Cygnus A, Taurus A, and Virgo A are also discussed. Some implications for the analysis of N−S relations, source spectra, and calibration of large antennas are mentioned. (auth)

18559 POSSIBLE IDENTIFICATION OF X PERSEI WITH AN X RAY SOURCE. Van den Bergh, S. (Univ. of Toronto). Nature (London); 235: No. 5336, 273-4(4 Feb 1972).

It has been found that the position of the irregular variable star X Persei coincides with that of the x-ray source 2 ASE 0352 + 30, and the very unusual nature of X Persei lends some support to the speculation that the positional agreement of this star with an x-ray source may not be a chance coincidence. It has also been suggested that X Persei and the high-velocity O star ξ Persei originally formed a physical binary system that disintegrated when X Persei became a supernova. The identification of X Persei with an x-ray source would lend considerable support to this suggestion. (UK)

18560 X PERSEI AN X RAY SOURCE. Braes, L. L. E.; Miley, G. K. (Leiden Observatory). Nature (London); 235: No. 5336, 273(4 Feb 1972).

Arguments are presented suggesting that the peculiar star X Per is connected with the Uhuru x-ray source 2 ASE 0352 + 30. Supporting observations made in May 1971 with the Westerbork synthesis radio telescope are reported. (UK)

18561 IDENTIFICATION OF CYGNUS X-1 WITH HDE 226868. Bolton, C. T. (Univ. of Toronto). Nature (London); 235: No. 5336, 271-3(4 Feb 1972).

It has been found that the ninth-magnitude B0 1b star HDE 226868 is clearly coincident with the position of Cygnus X-1 and its associated variable radio source. It has also been pointed out that Cyg X-1 appears to be a two-component x-ray source, one component having a synchrotron spectrum and the other a thermal (bremsstrahlung) spectrum. The latter component varies on a time scale of days in a way that suggests it is being eclipsed. The present communication describes photographic spectra of HDE 226868, taken in September to November 1971 with the 74-inch telescope of the David Dunlop Observatory at Richmond Hill, Ontario, with a view to looking for velocity and spectrum variations that might be correlated with the x-ray fluctuations. It was found that the velocity of the star varies with a period consistent with that of the x-ray variation; it may not be possible, however, to interpret the x-ray variations in terms of simple eclipses. Various features of the velocity curve are discussed. The crucial point in identifying HDE 226868 with Cyg X-1 is stated to be in the comparison of the x-ray period with the velocity period; a period of 5.607 days fitted the x-ray and radial velocity data very well. The data seem to indicate that there is a gas stream moving from the B star toward the unseen companion and the motion of the gas stream and the apparent position of the x-ray source strongly suggest that the x rays are produced through the interaction of the gas stream and the unseen companion. The high energies of the x rays imply that large accelerations are involved, such as might be produced by the intense gravitational field of a collapsed object, and there appears to be a distinct possibility that the secondary is a "black hole". The good agreement between the velocity variations of HDE 226868 and the x-ray variations of Cyg X-1, combined with their close positional coincidence, argues strongly for their identity. Several problems remain, however, and the true nature of the x-ray variation can only be adequately determined by continuous monitoring of Cyg X-1 over a large energy range, and this should be coordinated with optical and radio observations. (UK)

18562 POSITION AND IDENTIFICATION OF THE CYGNUS X-1 RADIO SOURCE. Wade, C. M.; Hjellming, R. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London); 235: No. 5336, 271(4 Feb 1972).

It is stated that initial estimates of the positon of the radio source associated with the x-ray source Cygnus X-1 were uncertain by 3 to 5 arc sec and were consistent with two possible identifications with stars: the 8.9 mag. B0 1b star HDE 226868 and a 15 mag. red star 9 arc sec to the NW of the B star. Observations are reported that resolve this ambiguity, by an accurate determination of the radio position. The observations were made at frequencies of 2,695 and 8,085 MHz with the NRAO three-element interferometer on Oct. 28 to 31, 1971. Nearly perfect positional coincidence between the radio source and the star left no doubt that HDE 226868 is the correct identification. Flux densities are also given. Spectroscopic evidence is also mentioned that strongly supports identification of the radio and x-ray sources with the HDE 226868 binary system. (UK)

18563 PULSAR DATA AND THE DISPERSION RELATION FOR LIGHT. Rawls, John M. (Yale Univ., New Haven). Phys. Rev., D; 5: No. 2, 487-9(15 Jan 1972).

Recent observations of pulsed γ radiation from NP 0532 provide a very accurate check on the dispersion relation obeyed by light. The data are sufficient to rule out the mechanism proposed by Pavlopoulos for breaking Lorentz invariance. (auth)

Solar Phenomena

Refer also to abstract 19541.

18564 (AD-731167) SUDDEN FREQUENCY DEVIATIONS, SOLAR EXTREME ULTRAVIOLETS BURSTS, AND SOLAR RADIO BURSTS. Environmental Research Papers. Richards, David W. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 9 Jul 1971. 27p. (AFCRL-71-392; AFCRL-ERP-363). NTIS.

An investigation was made of the interrelationship of solar extreme ultraviolet (euv) bursts, solar radio bursts, and terrestrial ionispheric sudden frequency deviations (SFD's). No direct general relationships between radio spectra or burst intensities and SFD incidence or magnitude (Δf) were found. If the euv enhancement is greater than 3% at λ 304 or λ 630 A, there is an 85% probability of occurrence of an SFD. Time of maxima of euv and radio bursts are found to coincide extremely well. (auth) (USGRDR)

18565 (AD-731403) DIFFERENTIAL ROTATION IN THE SOLAR ATMOSPHERE INFERRED FROM OPTICAL, RADIO, AND INTERPLANETARY DATA. El-Raey, Mohamed; Scherrer, Philip (California Univ., Berkeley. Space Sciences Lab.). 1971. Contracts N00014-69-A-0200-1047; N00014-69-A-0200-1049. 14p. NTIS.

Autocorrelation analysis of sunspot number, solar radio flux, and interplanetary field in the period 1967 to 1970 yields valuable information concerning solar atmospheric rotation. The upper chromosphere and the lower corona are rotating on the average about 5 to 8% faster than are either the photosphere or the upper corona. In addition, short-lived features in the chromosphere and lower corona are found to rotate sometimes as much as 10% faster than relatively long-lived features at the same height. Coronal and photospheric features are found to rotate more or less synchronously. Analysis of yearly data has indicated a considerable change in rotation periods from one year to another. (auth) (USGRDR)

18566 (N-72-10832) DYNAMICS OF THE SOLAR WIND AND ITS INTERACTION WITH BODIES IN THE SOLAR SYSTEM. Quarterly Progress Report, July 1-September 3, 1971. Spreiter, John R. (Stanford Univ., Calif. Dept. of Applied Mechanics). 30 Sep 1971. 102p. (NASA-CR-123291). NTIS.

The solar wind and its interaction with bodies of the solar system are discussed. An overall unified account of the role of the shock waves in the heating of the solar corona, the transmission of solar disturbances of the solar system, the flow fields of planets and natural satellites, and biological effects are provided. An analysis of magnetometer data from Explorer 33 and Vela 3A satellites to identify characteristics of solar-wind shock waves is included. (auth) (STAR)

18567 PROBLEM OF SCALES AND FORMS OF MANIFESTATIONS OF THE EFFECT OF SOLAR ACTIVITY. Baidal, M. Kh. Tr. Nauch.-Issled. Gidrometeorol. Inst. (Alma-Ata); No. 38, 19-21(1969). (In Russian).

The claim that the effect of solar activity on the atmospheric circulation and weather is either insignificant or nonexistent was disproved. At the same time, it was noted that attempts to prove the predominant role of solar activity in causing fluctuations of the atmospheric circulation are erroneous. It is shown that the effect of solar activity is manifested on the overall planetary, as well as local, scale and the integral effect of solar activity is extremely important, although its energy is much lower than the energy of the atmospheric circulation. (Meteorol. Geoastrophys. Abstr.)

18568 EFFECT OF SOLAR ACTIVITY ON ATMOSPHERIC PRECIPITATIONS. Baidal, M. Kh. Tr. Nauch.-Issled. Gidrometeorol. Inst. (Alma-Ata); No. 38, 22-4(1969). (In Russian).

The probability of catastrophic droughts reflects the combination of the direct and indirect effects of solar activity on precipitations. Solar activity affects precipitations indirectly through its influence on atmospheric circulation. In Kazakhstan, in the years of maximum as well as minimum solar activity, these two effects on precipitation can have the same sign. In the years of the maximum, they act against the drought, but in the years of the minimum, they may cause the formation of droughts. The two types of effects of solar activity at the maximum and minimum of solar activity have different signs in the Ukraine. (Meteorol. Geoastrophys. Abstr.)

18569 UNSEIZABLE NEUTRINO. PART II. NEUTRINOS FROM OUTSIDE THE EARTH AND THEIR USES IN ASTRONOMY. Kuchowicz, B. (Univ., Warsaw). Fiz. Szk.; 15: No. 6, 12-23(1969). (In Polish).

Thermonuclear reactions in stars are reviewed, with special emphasis upon processes in which neutrinos are produced. It is

emphasized that detection of such neutrinos may be the only direct test for nuclear processes being the source of solar energy emission. The flux of solar neutrinos is estimated. Radiochemical experiments performed by Davis are presented with their recent results. Other neutrino experiments are performed by using direct counting methods, e.g., emission of high-energy electrons in neutrino-capture processes. As in the Davis experiment, the detector, in this case, is located in a mine underground. Besides experiments with solar neutrinos other experiments are performed with other cosmic neutrinos and antineutrinos, both from primary cosmic radiation and from secondary production processes in the atmosphere. Muonic neutrinos may be detected, thanks to the production of muons in underground detectors. (auth) (NSA of Poland)

18570 GENERATION OF BREMSSTRAHLUNG X-RAYS FROM SOLAR CORONA. Singh, R. N.; Prasad, R. Y. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 9: No. 10, 833-6(Oct 1971).

The free–free transition of an electron in the Coulomb field of an ion is considered to produce bremsstrahlung radiation from the solar corona. This process covers a wide range of the electromagnetic spectrum. With the help of electron and ion density distribution, thermal equilibrium temperature and its height variation, the x-ray flux in the wavelength range 1 to 100 Å arising from the solar corona was computed. The solar x-ray flux reaching the ionospheric height is compared with the bremsstrahlung x rays generated by energetic-particle precipitation. The special observed features are discussed in terms of well-known coronal phenomena. (auth)

18571 MAXIMUM TEMPERATURES FOR RADIATION FROM PLASMA WAVES. Smith, D. F. (High Altitude Observatory, Boulder, Colo.); Sturrock, P. A. Astrophys. Space Sci.; 12: No. 2, 411-14(Aug 1971).

Upper limits to the radiation temperatures $T^t(k)$ for emission near the fundamental and second harmonic of the electron plasma frequency were derived in terms of the effective temperature for plasma waves $T^l(k')$. It was found that $T^t(k) \lesssim (c/(3)^{\frac{1}{2}} V_e)^3 T^l(k')$ for emission near the fundamental, which differs from the result of Melrose (1970b) by the factor in parentheses. This factor can exceed 4×10^4 in some plasmas. The conditions under which this limit could be reached are delineated. For emission near the second harmonic, $T^{t(l)} \leq T^l(k')$, since the absorption coefficient in this case can only be positive. (auth)

18572 MASS DISTRIBUTION IN THE SOLAR SYSTEM. Mitra, Ved (MNR Engineering Coll., Allahabad, India). Astrophys. Space Sci.; 12: No. 2, 471-83(Aug 1971).

The present-day observed mass distribution in the solar system, including the Sun, is shown to be compatible with the idea of the splitting of a number of ring-shaped rotating clouds of particles in the equatorial plane of a single contracting nebula. The formation of such a nebula is discussed and it is inferred that, during the course of contraction, this nebula has remained a sphere of uniform density spinning with the Keplerian velocity of its surface layer. The mass of a planet is taken as the portion of this spherical solar nebula gained at the time of splitting by its gaseous ring of dimensions satisfying Roche and accretional limits. (auth)

18573 MECHANISMS FOR FACULAR EMISSION IN THE Ca^+ H AND K LINES AND INFRARED TRIPLET. Polupan, P. N. (Kiev State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 576-81(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 730-7(Jul-Aug 1971).

The principal mechanisms for emission of a facula in the H and K lines and the infrared triplet of Ca^+ are shown to be resonance scattering of photospheric radiation and electron collision. (auth)

18574 IONIZATION AND EXCITATION OF HELIUM IN PROMINENCES. Kostik, R. I. (Central Astronomical Observatory, Kiev). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 582-8(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 738-46(Jul-Aug 1971).

The steady-state equations for five helium energy levels are formulated and solved simultaneously with the equations of transfer for an optically thick prominence with plane-parallel geometry. The calculations indicated that the observed populations of the triplet levels of helium atoms in prominences can be explained by a recombination excitation mechanism for electron temperatures T_e = 5000 to 10,000°K and electron concentrations $n_e = 10^{11}$ to 10^{12} cm^{-3}. The helium is ionized primarily by photospheric radiation and the diffuse short-wave radiation field. Complete redistribution of energy with respect to frequency in an elementary scattering event is assumed in the calculations. (auth)

18575 EMISSIVITY AND TEMPERATURE STRUCTURE OF THE CORONAL PLASMA. Vil'koviskii, E. Ya.; Obashev, S. O. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 589-92(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 747-51(Jul-Aug 1971).

An analysis of the cooling rate in the thermal-balance equation for the coronal plasma indicates that three regions of temperature stability exist in the solar corona. The emission of Fe ions would be particularly important if the abundance ratio $N_{Fe}/N_H > 3 \cdot 10^{-5}$. (auth)

18576 COMET BRIGHTNESS VARIATIONS AND THE CONDITIONS IN INTERPLANETARY SPACE. Andrienko, D. A.; Demenko, A. A.; Demenko, I. M.; Zosimovich, I. D. (Kiev State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 666-71(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 843-9(Jul-Aug 1971).

Studies of cometary brightness fluctuations may afford a valuable method for ascertaining conditions in interplanetary space. The light curves of various comets were compared with curves for the geomagnetic-field indices. Photometric observations of the brightness of 30 comets from 1874 to 1937 were used. The following conclusions were inferred from an analysis of the correlation between cometary brightness and the geomagnetic-field variation. (1) Flares and integrated-brightness variations of comets are closely related to solar corpuscular radiation. (2) The best circumstances for comparing cometary brightness with the geomagnetic field occur when a comet passes near the ecliptic plane, since the comet and the Earth are then exposed to the same corpuscular streams. (3) From the correlation coefficients determined in this way one can estimate the angular diameter of the corpuscular streams (it may reach 80°). (4) An examination of the interaction between solar interplanetary plasma and cometary material indicates that solar corpuscular streams are stable. (5) The highest correlation coefficients are found at short distances from the Sun (0.5 to 0.8 A.U.). The correlation practically vanishes beyond 1.5 A.U., presumably because of the dispersal of corpuscular streams far from the Sun. (6) Studies of cometary brightness variations are highly important for understanding not only the geometrical properties of solar corpuscular radiation, but also the physical parameters of the solar wind and of corpuscular streams at large distances from the Sun and at high heliographic latitudes, where direct measurements are not yet practicable. (auth)

18577 MEASUREMENTS OF THE TRANSVERSE MAGNETIC FIELD IN THE CHROMOSPHERE ABOVE A SUNSPOT. Kotov, V. A. (Crimean Astrophysical Observatory, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 687-8(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 869-71(Jul-Aug 1971).

An attempt was made with the magnetograph of the Crimean Astrophysical Observatory to measure the vector H in a sunspot at the photospheric level (in the λ 5250 line) and in the Hα line simultaneously. A strong variation (up to 74°) was found in the orientation of the transverse field $H_\perp$ in certain portions of the sunspot with transition from the photospheric level to the chromosphere, although at many points the $H_\perp$ vectors are parallel at the two levels. The chromospheric magnetic field, just as at the photospheric level, resembles a fan of diverging lines of force. (auth)

18578 TOWARDS A THEORY OF JET STREAMS. Trulsen, Jan (Univ. of Tromsoe, Norway). Astrophys. Space Sci.; 12: No. 2, 329-48(Aug 1971).

A kinetic equation for a jet stream consisting of identical, partially inelastic grains in neighboring orbits around a central gravitating body is derived and given a preliminary discussion. No nonsingular equilibrium state exists for the jet stream configuration. The Boyle–Mariotte ideal gas law does not apply. The effect of hard, partially inelastic collisions is to decrease the kinetic temperature of the stream, thereby leading to a lining-up of the orbits of the individual grains with a subsequent reduction in the importance of collisions on the dynamics of the stream. (auth)

18579 REVERSE DEFLECTION AND CONTRACTION OF A PLASMA BEAM MOVING ALONG CURVED MAGNETIC FIELD LINES. Lindberg, L.; Kristoferson, L. (Royal Inst. of Tech., Stockholm). Cosmic Electrodyn.; 2: No. 3, 305-8(Oct 1971).

A plasma beam which originally moves in a longitudinal magnetic field and enters a region of curved magnetic field was investigated experimentally. It was found that the beam contracts perpendicular to the v × B direction, and the whole beam becomes deflected in the direction opposite to that in which the magnetic field is curved. The deflection is caused by propagation backwards of the transverse electric field, which is induced when the beam enters the region with curved field. (auth)

18580 AVERAGE SOLAR WIND PROTON PROPERTIES FROM PIONEERS 6 AND 7. Mihalov, John D.; Wolfe, John H. (Ames Research Center, Moffett Field, Calif.). Cosmic Electrodyn.; 2: No. 3, 326-39(Oct 1971).

Distributions and average values for the proton speed, azimuthal and polar flow directions, and the proton temperature and density in the solar wind are presented. The data were obtained from the Ames plasma probes on Pioneers 6 and 7. The time periods covered include December 18, 1965 to mid-February 1966, and mid-August to mid-October 1966. The distributions of the parameters, except for the polar flow direction, were skewed, partially because of stream–stream interactions in the solar wind. The average values of the basic plasma parameters from the two spacecraft were different, which could be due partially to different solar activity at the two times, and partially to sector and beam structure dependence. (auth)

18581 STRUCTURE OF THE INTERPLANETARY MAGNETIC FIELD. Stenflo, J. O. (National Center for Atmospheric Research, Boulder, Colo.). Cosmic Electrodyn.; 2: No. 3, 309-25 (Oct 1971).

A method to calculate the three-dimensional structure of the interplanetary magnetic field from the observed line-of-sight component of the field in the solar photosphere is described. Computer-drawn pictures of the coronal and interplanetary fields out to the orbit of Earth are presented. The interplanetary magnetic field around the time of the November 12, 1966 total solar eclipse shows a clean dipole-type structure, while the field around the time of the March 7, 1970 solar eclipse is more complicated and has four sectors. The field calculated in the ecliptic plane at 1 AU shows good agreement with spacecraft observations. (auth)

18582 LOW-FREQUENCY OSCILLATORY CONVECTION IN THE STRONG MAGNETIC FIELD. Zhugzhda, Y. D. (Inst. of Earth Magnetism, Ionosphere, and Propagation of Radiowaves, Moscow). Cosmic Electrodyn.; 2: No. 3, 267-79(Oct 1971).

The conditions that can give rise to low-frequency convective oscillations in polytropic atmospheres in the presence of arbitrarily strong magnetic fields were studied. With the defined criteria of instability, no conditions are imposed on the character of the heat-exchange between convective cells. Two limiting cases were examined—quasi-adiabatic and quasi-isothermal oscillations. The boundary problems of the proper values for adiabatic and isothermal oscillations may be solved exactly. The increments of quasi-adiabatic and quasi-isothermal oscillations may be found with the aid of the first approximation of the perturbation theory. The mechanism of the growth of the type of instability considered is discussed, as is the possibility of low-frequency convection in solar sunspots. (auth)

18583 COMETS AND THEIR INTERACTION WITH THE SOLAR WIND. Biermann, L. (Max-Planck Inst. for Physics and Astrophysics, Munich). Quart. J. Roy. Astron. Soc.; 12: No. 4, 417-32(Dec 1971).

A survey is first presented of the main observational and theoretical results that led to the conclusion that the total amount of the gas production of a comet exceeds that of the molecules visible from the ground in the ordinary spectral range by two or three powers of ten. This development included a prediction of the properties of cometary hydrogen atmospheres. Observational results obtained with the Orbiting Astronomy Observatory and Orbiting Geophysical Observatory are then described. A review is given of some work on the fluid dynamics of the interaction of the solar wind with a comet. In conclusion some comments are made on the main recent changes in the overall picture of the interaction of the solar wind with comets. (UK)

18584 TIME FLUCTUATIONS OF THE GENERAL MAGNETIC FIELD OF THE SUN. Severny, A. B. (Crimean Astrophysical Observatory, USSR). Quart. J. Roy. Astron. Soc.; 12: No. 4, 363-79(Dec 1971).

The subject is discussed under the following headings: fine structure of the solar general magnetic field; time fluctuations of the general magnetic field; difference in rotation of N and S polarities; nature and origin of the mean solar magnetic field (possible connection with sunspot magnetic fields; mean solar and interplanetary fields and possible connections with active regions); rapid fluctuations; and magnetic asymmetry. (UK)

18585 SOLAR WIND. Cowling, T. G. (Univ. of Leeds, Eng.). Quart. J. Roy. Astron. Soc.; 12: No. 4, 447-52(Dec 1971).

An historical introduction is followed by an account of the general properties of the solar wind and a discussion of discontinuities in the wind. (UK)

18586 POLARIZATION OF SKYLIGHT NEAR THE SUN AND ITS INFLUENCE ON POLARIMETRIC K CORONA OBSERVATIONS. Leroy, J. L.; Muller, R.; Poulain, P. (Observatoire du Pic-du Midi, Bagneres-de-Bigorre, France). Astron. Astrophys.; 17: No. 2, 301-8(Mar 1972).

The problem of the polarization of skylight near the Sun is considered as a source of perturbations for polarimetric measurements of the K corona from the ground, without eclipse. The investigation was limited to a single spectral region ($\lambda \cong 5000$ Å) for observations recorded at high-altitude observatories (altitude $\cong 3000$ m) where coronal observations are mostly performed. (W.D.M.)

18587 INTERFEROMETRY APPLIED TO VISIBLE SOLAR FEATURES. Harvey, J. W. (Kitt Peak National Observatory, Tucson, Ariz.). Nature (London) Phys. Sci.; 235: No. 57, 90-1(31 Jan 1972).

It is stated that, as far as the author knows, the technique of wave-front division interferometry (Michelson, Astrophys. J., 51: 257(1920)) has not been applied to visible solar features, although it is widely used in radio solar observations. It is shown that interferometry can be applied successfully to the study of small-scale features at visible wavelengths, and some observations are described. The basis of the method is described. Fringes demonstrating the existence of small features in and around a small sunspot are shown on a photograph taken on Oct. 10, 1971. The fringes demonstrate the existence of solar features with dimensions of the order of 100 km or smaller. Photographs of a large sunspot and nearby faculae situated a few arc sec from the limb were also obtained; fringes were clearly seen in the penumbra of the spot, a light bridge crossing the umbra and some of the facular areas. No fringes were seen at the limb. It was concluded that the technique is potentially suitable for investigation of such solar features as sunspots, faculae, magnetic field elements, and chromospheric structures such as Ellerman bombs, flares, and prominences. (UK)

18588 SPIKE BURST: TYPE III BURST ASSOCIATIONS. Tarnstrom, G. L.; Philip, K. W. (Univ. of Alaska, College). Astron. Astrophys.; 17: No. 2, 267-75(Mar 1972).

High-time-resolution ($\lesssim 0.01$ s) spectral observations of meter-wavelength solar radio Type III burst events reveal occasional spike burst–Type III burst associations which fall into three classes. Also observed were Type III bursts of ≈ 0.1 s duration at one frequency, resembling large-frequency range spike bursts and suggesting a morphological continuity between spike bursts and Type III bursts. A plasma hypothesis interpretation of spike bursts requires burst exciters of spatial extent less than $\approx 10^3$ to 10^4 km, stream density ≈ 1 to 10 electrons/cm^3, and coronal temperature $\approx 10^{6}$°K. It is suggested that the spatial extent of a given exciter determines whether a spike burst or a Type III burst is produced. (auth)

18589 INTERPRETATION OF THE RELATIVE INTENSITIES OF THE SOLAR XUV LINES OF IONS IN THE LITHIUM ISOELECTRONIC SEQUENCE. Flower, D. R. (Observatoire de Paris, Meudon, France). Astron. Astrophys.; 17: No. 2, 201-6(Mar 1972).

Observations of solar xuv emission lines of ions in the lithium isoelectronic sequence were re-examined in the light of recent calculations of electron excitation cross sections for the relevant transitions. The temperatures deduced from the observations were not in satisfactory agreement with the temperatures at which the observed lines are most efficiently produced according to currently accepted theories of the ionization equilibrium. Confirmation of this conclusion, which would have far-reaching implications, must await further observations of the same type and the removal of remaining uncertainties in the values of the collision strengths. (auth)

18590 SOLAR NEUTRINOS AND THE ^{37}Cl NEUTRINO ABSORPTION EXPERIMENT. Bandyopadhyay, P. (Indian Statistical Inst., Calcutta). J. Phys., A (London); 5: No. 1, L19-23(Jan 1972).

On the basis of a certain lepton–hadron relation and the dynamical origin of charge, the cross section for the scattering process $\nu_e + {}^{37}\mathrm{Cl} \rightarrow {}^{37}\mathrm{Ar} + e^-$ was computed. The product of the neutrino flux and the cross sections for all sources of solar neutrinos, when calculated using this modified value of the scattering cross section, is found to agree well with the experimental observations. Also, from this analysis, it is concluded that there is no reason to rule out the possibility that the Sun derives most of its radiated energy from the CNO cycle. (auth)

18591 DISTRIBUTION OF ELECTRIC CONDUCTIVITY AND ITS GRADIENTS IN THE PHOTOSPHERIC LAYERS OF AN ACTIVE REGION. Kopecky, M. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 22: No. 6, 343-6(1971).

An approximate general model of the distribution of electric conductivity and of the gradients of the electric conductivity in

the photospheric layers of an active region of the Sun, namely, in the vertical and the horizontal direction, is presented. At different locations and different geometrical depth the values of electric conductivity (8×10^9 to 3×10^{12}), the values of the gradients ($\Delta\sigma$ per 1 cm) of the electric conductivity (0 to 10^6) and the directions of these gradients vary. This means that relatively complicated systems of electric currents must exist in the active regions. (auth)

18592 RELATION OF SURGES TO SPOTGROUPS AND TO FLARES. Kleczek, J.; Kleczkova, H.; Kvicala, J. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 22: No. 6, 347-51(1971).

Nearly three thousand surges observed between July 1, 1957 and December 31, 1963 were investigated. Their association with spotgroups and with flares on the disc corroborated earlier findings. The larger the spotgroup, the larger the probability of surge occurrence. There were, however, surges occurring far from spotgroups. There were also surges not associated with a flare. The fact that flares and surges sometimes occur one without the other indicates that they are different phenomena even if they are often closely associated. The real duration of the surges was found from the material used. Most of the surges had lifetimes of 10 to 30 minutes. (auth)

18593 RATIO OF PENUMBRAL AND UMBRAL AREAS OF SUN-SPOTS IN THE 11-YEAR SOLAR ACTIVITY CYCLE. Antalova, A. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 22: No. 6, 352-70(1971).

The sunspot observations published in the Greenwich Observations in the years 1916–1960 were used in investigating the ratio of the penumbral and umbral areas in the years of the maximum of the 11-year solar cycle. (W.D.M.)

18594 TEMPERATURE OF SOLAR ACTIVE REGIONS ON A WAVELENGTH OF 2 cm. Tlamicha, A. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 22: No. 6, 371-5 (1971).

Measurements of the temperature of the active regions on the Sun at a wavelength of 2 cm by using the N.R.A.O. 43-m telescope are presented. The variation of the temperature of the active regions is between 10,000 and 24,000°K. (auth)

18595 PRELIMINARY ANALYSIS OF OBSERVATIONS OF THE CORONAL CONDENSATION OF SEPTEMBER 10, 1970. Rybansky, M. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 22: No. 6, 376-80(1971).

The observations and photometry concerning part of the data pertaining to the coronal condensation of September 10, 1970, are described. Fe XIV 5303 Å, Ca XIII 4086 Å, and Ca XV 5446 and 5694 Å emission lines and the K corona were observed. The electron density in the center of the condensation was determined as 1.7×10^{10} cm^{-3}. The velocity of the macroscopic matter in the condensation was determined as being between 10 and 20 km s^{-1}. (auth)

18596 ERUPTIVE PROMINENCE OF MAY 3, 1971. Rybansky, M. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 22: No. 6, 380-1(1971).

Observations of the eruptive prominence of May 3, 1971 are described. The prominence reached a height of 540,000 km. The maximum velocity observed was 200 km s^{-1}. (auth)

18597 INTERACTION OF ATOMS WITH POLARISED LIGHT. Lamb, F. K.; Ter Haar, D. (Dept. of Theoretical Physics, Oxford). Phys. Rep.; 2C: No. 4, 253-322(Nov-Dec 1971).

A discussion of the interaction of atoms with a partially polarized radiation field is presented. To some extent the differences in the populations of atomic states, quantum interference effects that occur when atomic states are overlapping, and collisional relaxation are taken into account. The theory is presented in such a way that it is particularly suitable for an application to solar lines. (188 references) (auth)

Galaxies

Refer also to abstracts 18496 and 18533.

18598 STATISTICAL SEARCH FOR INTERGALACTIC MATTER. Kwast, T. (Univ., Warsaw). Postepy Astron.; 19: No. 4, 335-42(Dec 1971). (In Polish).

Color excess of about 0.3m was estimated from counts of galaxies in some regions of the sky suspected to be obscured by intergalactic matter near clusters of galaxies Zw. 156–5 and Zw. 156–14. (auth)

18599 PROBLEM OF SUPERCLUSTERING OF GALAXIES. Karpowicz, Maria (Univ., Warsaw). Postepy Astron.; 19: No. 4, 313-24(Dec 1971). (In Polish).

Two essential views on the distribution of matter in the Universe are described. The methods and conclusions of the basic papers concerning the existence or the nonexistence of superclusters of galaxies are presented. Attention is paid to the difficulties connected with inevitable systematic errors of the data derived from the catalogs and to the uncertainty of applied statistical tests. (auth)

18600 COLOR–REDSHIFT RELATION FOR GIANT ELLIPTICAL GALAXIES. Tinsley, Beatrice M. (Univ. of Texas, Dallas). Astrophys. Space Sci.; 12: No. 2, 394-407(Aug 1971).

The colors of giant elliptical (gE) galaxies in clusters out to redshift z = 0.2, observed by Oke and Sandage (1968), were studied for systematic color–redshift effects. To reveal any intrinsic changes, the K term was subtracted from each color, after correction for galactic reddening and the resulting $(B-V)_c - K_{B-V}$ versus z relation analyzed. If the Oke and Sandage K terms (relevant to nuclear colors) were used, the best fitting linear relation showed negligible change with z. But if the Whitford (1970) K terms (relevant to integrated colors) were used, there was a trend to bluer colors, by 0.07 mag. at z = 0.2 if higher weight was given the better observed clusters. An upper limit, of ±0.08 mag. at z = 0.2, was set to possible systematic aperture effects, by the total change between nuclear and integrated B – V and U – B of nearby gE galaxies. The color–redshift trends, interpreted as evolution changes, are related to evolution in the magnitude–redshift relation by means of models of stellar evolution in a gE galaxy. If one uses the linear fit to the color–redshift relation obtained with Whitford K terms and neglect of any aperture effects (which is the appropriate case if Oke and Sandage used large enough apertures), and if one adopts plausible limits to the ratio between color and magnitude evolution, the effect of evolution in the magnitude–redshift relation results in a negative value of q_0. There are still substantial observational and theoretical uncertainties affecting this conclusion. (auth)

18601 BLAST WAVES IN ROTATING MEDIA. Rossner, L. F. (Brown Univ., Providence). Nature (London) Phys. Sci.; 235: No. 56, 68-9(24 Jan 1972).

Investigation of the propagation of blast waves in media rotating in a gravitational field was suggested by the accumulating evidence for the occurrence of violent events in the nuclei of galaxies, and a model involving a cylindrically symmetric blast wave generated by an infinitely long-line explosion in a cold and homogeneous gas rotating rigidly in its self-gravitational field is discussed in this context. (UK)

18602 NEUTRAL HYDROGEN STUDY OF THE GALAXY NGC 253. Huchtmeier, W. (Observatoire, Meudon, France). Astron. Astrophys.; 17: No. 2, 207-14(Mar 1972).

Observations with the 655-foot Nançay radio-telescope of the 21-cm hydrogen line of the galaxy NGC 253 yield a H I mass 7.8×10^9 $M_\odot$ or nearly 6% of the total mass of 1.3×10^{11} $M_\odot$ for a distance of 3.4 Mpc. The integrated H I contours indicate an asymmetry in the distribution of neutral hydrogen. There is 30% more neutral hydrogen on one side (SW) of the galaxy than on the other (NE). A deep central depression in the H I contour map cannot be explained by simple symmetric H I models; absorption of the emission from the strong central source by the H I in front is suspected. Parameters of the H I distribution and the rotation curve are deduced by a model-fitting procedure. Outside the central region of the galaxy only a small velocity dispersion (5 to 8 km/s) was found. (auth)

18603 LOCAL LINEARIZED VELOCITY FIELD IN THE PRESENCE OF A SPIRAL DENSITY WAVE. Rohlfs, Kristen (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 17: No. 2, 246-52(Mar 1972).

The streaming velocity of interstellar gas and young stars caused by spiral density waves is sufficiently large to cause detectable variations in the gradients of the galactic velocity field. Mathematical expressions for the variation of the Oort constant A and the deviation of the nodes for differential galactic rotation are derived from the Lin theory. It is shown that this deviation of the nodes can be determined both from 21-cm line observations and from radial-velocity measurements of early-type stars. These data are then used to derive estimates for some of the density-wave parameters and the position of the Sun relative to these waves. (auth)

18604 STUDY OF GALACTIC STRUCTURE WITH THE AID OF AN OBJECTIVE PRISM: A REGION IN CASSIOPEIA. Martin, N. (Observatoire, Marseille). Astron. Astrophys.; 17: No. 2, 253-66(Mar 1972). (In French).

Galactic survey was studied (longitude 117°) with objective-prism plates. A catalog gives radial velocities of 358 stars and distances of 254 stars, for 236 stars, distances as well as radial velocities were determined. The distances of O–B stars have two maxima, one situated at about 2.6 kpc, the other about 4.0 kpc, in agreement with the scheme of galactic structure studied by Isserstedt. Radial velocities were compatible with Oort's theory. The effect of quality is however very important. It is noted that quality A and B radial velocities are different from quality C radial velocities. If the results are compared with those of Schmidt, fairly good agreement is found for quality A–B stars, but stars of quality C differ much from the theoretical curve. (auth)

18605 EXPLANATION OF THE CLOUDY STRUCTURE OF THE INTERSTELLAR MEDIUM. Hills, J. G. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 17: No. 2, 155-60(Mar 1972).

The relatively numerous, widely distributed, hot prewhite dwarfs (UV stars) are found to have a profound influence on the interstellar gas. The overlapping Strömgren spheres of these stars result in a gaseous medium in which most of the volume is filled with ionized hydrogen while most of the mass remains un-ionized. This un-ionized material is compacted by the pressure of the encompassing H II medium into dense clouds, which occupy the spaces between the Strömgren spheres. This model predicts that the frequency of the H I clouds is on the same order as that of the UV stars which is observed to be the case. The theoretically determined flux of ionizing photons from these stars is ample to sustain the observed inter-cloud H II medium even if a substantial fraction of the energy of these stars is lost by neutrino rather than by photon emission. The model also predicts a monotonic increase in the fraction of the material which is ionized as one progresses towards the galactic center due to the increasing space density of UV stars. Within about 100 pc of the center all the gas is predicted to be ionized as is observed. The theory further predicts that H I clouds lying just outside this zone of complete ionization are small objects with average masses of less than 1 $M_\odot$ but with average densities of about 300 hydrogen atoms/cm^3. These small, dense objects more closely resemble the dark globules associated with conventional H II regions rather than the more familiar H I clouds of the solar neighborhood. The number of H I clouds per unit volume in this zone is about 10^3 times greater than in the solar neighborhood. (auth)

18606 IS POLYOXYMETHYLENE A COSMOPOLYMER. Roche, R. S. (Weizmann Inst. of Science, Rehovot, Israel). Nature (London); 235: No. 5335, 217(28 Jan 1972).

It is stated that the chemical reactions of formaldehyde under interstellar conditions may be of considerable relevance to discussions of the chemical evolution of the Galaxy. One of the more interesting chemical reactions of formaldehyde in the laboratory is its easy polymerization to high molecular weight linear macromolecules having a predominantly polyoxymethlene chain structure. The question arises as to whether formaldehyde can react in a similar way in the dense, cold clouds of the interstellar medium, and is polyoxymethlene a cosmopolymer. The thermodynamic stability of polyoxymethlene under the conditions thought to prevail in the interstellar clouds is first examined. It is also known that the polymerization of formaldehyde can be initiated by γ and x rays, and occurs in the gas, liquid, and solid phases. The interesting temperature range is 50 to 100°K (H I regions) over which it is not unrealistic to expect chemical reactions to occur at a rate consistent with the time scale (10^2 to 10^8 y) on which interstellar chemical processes occur, and it is possible that interstellar grains may be a locus for complex chemical reactions. Linear macromolecules of the type of grain constituent and polymerization may be one nucleation mechanism for their formation. (UK)

18607 INTERACTION OF ROTATING INTERSTELLAR GRAINS WITH COSMIC LOW FREQUENCY RADIATION. Martin, P. G. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 283-91(1972).

The effect of the low frequency (MHz) interstellar radiation on the angular momentum distribution of interstellar grains with permanent dipole moments is examined. It is shown that if this process is to effectively compete against isotropic bombardment by hydrogen atoms and thereby affect grain alignment, then the grains must possess dipole moments characteristic of ferromagnetic or ferroelectric materials. Small iron grains, which have been suggested as contributors to the visible extinction, should be strongly affected. Some aspects of the origin of the low-frequency radiation relevant to this problem are discussed. (auth)

18608 HIGH RESOLUTION OBSERVATIONS OF NEUTRAL HYDROGEN IN M33. I. THE HYDROGEN DISTRIBUTION. Wright, M. C. H.; Warner, P. J.; Baldwin, J. E. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 337-56(1972).

Observations of the galaxy M33 at 21-cm wavelength enabled the neutral hydrogen to be mapped with an angular resolution of $1.5 \times 3.0'$ and a velocity resolution of 39 km s^{-1}. The distribution of neutral hydrogen is roughly uniform out to a distance of 5 kpc from the nucleus, and it is approximately coextensive with the visible disk of the galaxy. H I features are associated with the stellar spiral structure. Two H I extensions at the ends of the major axis may be due to warping of the hydrogen plane. (auth)

Cosmology

Refer also to abstract 18598.

18609 SOME GENERAL PROPERTIES OF GRAVITATIONAL SYSTEMS. Gurevich, L. E. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 566-9(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 716-21(Jul-Aug 1971).

Although statistical equilibrium can never be reached in a gravitating system, a tendency toward equilibrium should appear to some extent as the system evolves. It is shown that such a tendency should be manifested in two ways. First, if statistical equilibrium prevails in a gravitating system comprising a large number of individual objects (stars or galaxies), subsystems of very large and very small multiplicity, but not of intermediate multiplicity, should form. During the elastic evolutionary phase a subsystem of high multiplicity will be stable against collisions with individual objects. If such subsystems occur in the system a situation may arise analogous to the admixture of massive and light stars considered by Spitzer. Secondly, even in the event that the system consists of objects of identical mass but is capable of elastic or evaporative evolution, nucleus and halo components would be discriminated; the size of the halo would be proportional to the size of the nucleus and the square root of the mass of the system. (auth)

18610 COMPUTERIZED SERIES SOLUTION OF RELATIVISTIC EQUATIONS OF MOTION. Broucke, R. (Univ. of California, Los Angeles. Jet Propulsion Lab., Pasadena, Calif.). Astrophys. Space Sci.; 12: No. 2, 266-77(Aug 1971).

A method of solution of the equations of planetary motion is described. It consists of the use of numerical general perturbations in orbital elements and in rectangular coordinates. The solution is expanded in Fourier series in the mean anomaly with the aid of harmonic analysis and computerized series manipulation techniques. A detailed application to the relativistic motion of the planet Mercury is described both for Schwarzschild and isotropic coordinates. (auth)

18611 POSSIBLE SELECTION EFFECTS AND THEIR CONSEQUENCES ON THE DETERMINATION OF THE MODEL OF THE UNIVERSE FROM THE REDSHIFT-MAGNITUDE RELATION OF THE BRIGHTEST CLUSTER GALAXIES. Vignato, A.; Marcucci, R. (Osservatorio Astronomico, Rome). Astrophys. Space Sci.; 12: No. 2, 456-70(Aug 1971).

Because of a suspicion that a positive correlation exists between the luminosity of the first-class galaxies and the richness of the clusters, an attempt is made at taking into account the difference in richness (and presumably in total population) between the clusters with $z < 0.1$ and the ones with $0.1 < z \leq 0.2$ (all being in the list of Peach, 1969) in the analysis of the redshift–magnitude relation of the brightest members. The analysis carried out with the clusters of richness 1 and 2, both present in the intervals of redshift 0.0 to 0.1 and 0.1 to 0.2, supports the steady-state model of the Universe, in comparison with the category of the models with $\Lambda = 0$. The result induces another kind of selection effect, due to difference in the mean space density of the data points between the region with $z < 0.1$ and the one with $0.1 < z \leq 0.2$, the mean volume "occupied" by the observed cluster being correlated with the luminosity of its brightest galaxy; also, in this case, the analysis supports the steady-state cosmology, while the tendency is clearly towards a lower value of q_0. The last result brings into consideration the models of the Universe with $\Lambda = 0$; results obtained are compatible with those obtained by the analysis of other relations, i.e., log N–log S of the 3C sources, the N–z relation of the quasi-stellar objects, and M–z for brightest quasars. (auth)

18612 RELATIVISTIC COSMOLOGICAL MODELS WITH PRESSURE. Sistero, R. F. (Univ., Cordoba, Argentina). Astrophys. Space Sci.; 12: No. 2, 484-92(Aug 1971).

Cosmological models with pressure are considered. A general method of solving Einstein's equations is presented in the usual de-

scription, i.e., in terms of the scale factor R(t). Its general application to models containing interacting radiation and matter is explicitly given. A particular class of models is studied that are "radiation-like" in their early history and "matter-like" at present. Their analytic solutions are given for all three values of the space-curvature constant. (auth)

18613 CREATION OF MATTER IN THE FRIEDMAN MODEL OF THE UNIVERSE. Grib, A. A.; Mamaev, S. G. (Leningrad State Univ.). Yadern. Fiz.; 14: No. 4, 800-5(Oct 1971). (In Russian).

The quantum theory of the scalar field in the Friedmann space–time at early stage of the evolution (the hot model of the Universe) is considered. The nonstationary character of the metrics results in a new, absent in the flat space–time, effect of the matter creation from the vacuum. Estimates are obtained for the density of the created matter, which is found to be very substantial. The Goldstone theorem for the Friedmann space is quoted, and properties of the Goldstone bosons are discussed. (auth)

18614 TIRED LIGHT AND THE MISSING MASS PROBLEM. Yourgrau, W.; Woodward, J. F. (Univ. of Denver). Acta Phys. Acad. Sci. Hung.; 30: No. 3, 323-9(1971).

All current cosmologies interpret the cosmological redshift as a genuine Doppler shift. However, when the systematic redshifts of the galaxies were first discovered, it was proposed by MacMillan that perhaps the redshifts were due to a secular decrease in the frequency of light as it traveled through space—the well known "tired light" hypothesis. It is demonstrated that this hypothesis is a viable solution to the "missing-mass" paradox. (W.D.M.)

18615 GRAVITATIONAL RED SHIFT: A THREE-BODY EFFECT. Peres, Asher (Israel Inst. of Tech., Haifa). Amer. J. Phys.; 40: No. 3, 398-400(Mar 1972).

The nonlinearity of Einstein's gravitational equations produces three-body forces in the equations of motion. One of their consequences is that the motion of an electron around a nucleus (or a satellite around a planet) is slowed down by the existence of a distant massive body. This is the familiar gravitational redshift, which can thus be derived without invoking the equivalence principle. (auth)

18616 DIFFUSE BACKGROUND OF GRAVITATIONAL RADIATION IN THE UNIVERSE. Sibgatullin, N. R. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 200: No. 2, 308-13(11 Sep 1971). (In Russian).

Relativistic equations of gravitation may be essential for describing the hypothetical gravitational radiation. The latter is discussed as a background for random fluctuations of the gravitational field. The influence of this background on the evolution of an average universe is discussed, with the consideration that the fluctuations of the gravitational field possess macroscopic (turbulent) nature rather than a quantum one. (K.S.W.)

18617 COSMOLOGICAL MODELS IN A CONFORMALLY INVARIANT GRAVITATIONAL THEORY. I. THE FRIEDMANN MODELS. Hoyle, F.; Narlikar, J. V. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 305-21(1972).

The formulation of the Friedmann cosmological models is discussed in terms of a conformally invariant gravitational theory. This theory is Machian in the sense that the mass of a particle arises from the interaction of the particle with a mass field m(X) generated by other particles. In cosmology the mass field m(X) at any particular space–time point X arises predominantly from particles at great distance from X. (UK)

18618 COSMOLOGICAL MODELS IN A CONFORMALLY INVARIANT GRAVITATIONAL THEORY. II. A NEW MODEL. Hoyle, F.; Narlikar, J. V. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 3, 323-35(1972).

It was seen previously (Mon. Notic. Roy. Astron. Soc. 155; No. 3, 305(1972)) how the mass of a particle can be determined in terms of a mass field m(X). A dimensionless coupling λ constant is introduced, the individual particle mass being $\lambda m(X)$. Since the mass field can be explicitly calculated in terms of cosmic time τ and L^{-3}, the cosmic-particle density, the numerical value of λ can be determined by relating $\lambda m(X)$ to empirically known particle masses. For the proton, $\lambda^2 \simeq 5 \times 10^{-38}$, which is of the same order as the inverse square root of the number of particles determining the present-day mass field. In the usual theory it has to be supposed that this circumstance arises from coincidence. If, on the other hand, λ^2 is actually related to the number of particles giving rise to the mass field a new cosmological model is obtained. Since the number of particles giving rise to the mass field is a function of the epoch τ, so must λ be. The model resulting from the dependence of λ on τ therefore involves continuous creation of matter. The situation here is different from the steady-state model, however. With creation occurring in active centers rather than smoothly, the model has radically new astrophysical and geophysical properties. These are examined in some detail. (auth)

18619 CUTTING THE GALAXY'S LOSSES. Sciama, Dennis (Oxford Univ.). New Sci.; 53: No. 783, 373-4(17 Feb 1972).

Does gravitational wave astronomy exist? Weber's experiments seem to imply either that the Galaxy is losing mass at an alarming rate, or that general relativity is wrong. Theorists are striving to cut down the predicted mass-loss in preference to rejecting the laws of physics. (auth)

18620 POINT SOURCES IN A NONHOMOGENEOUS UNIVERSE. de Felice, F. (Univ., Padua). Nuovo Cim.; 7B: No. 2, 333-40(11 Feb 1972).

Use was made of the linear perturbation theory to calculate the luminosity of a point source in a nonhomogeneous Friedmann universe. (auth)

18621 EXTRAGALACTIC ORIGIN OF LOW ENERGY GAMMA RAYS. Damle, S. V.; Daniel, R. R.; Joseph, G.; Lavakare, P. J. (Tata Inst. of Fundamental Research, Bombay). Nature (London); 235: No. 5337, 319-20(11 Feb 1972).

It is stated that although the existence of a finite flux of diffuse cosmic photons in the energy region ~ 1 keV to ~ 1 MeV is well established, and from observations on the isotropy of the radiation in the energy region 1 to 100 keV it is generally believed that a dominant fraction of the radiation in this energy band, if not all of it, is of extragalactic origin, nevertheless at energies above ~ 200 keV there has been hitherto no observational evidence for the isotropy or otherwise of the diffuse radiation, although some authors have advanced indirect arguments in favor of its extragalactic nature. There have also been attempts to interpret the diffuse cosmic γ rays in the neighbourhood of 1 MeV as of galactic origin. From a study of the directionality of the diffuse cosmic γ rays between ~ 200 keV and 4 MeV the present authors present the first observational evidence of their extragalactic nature. The balloon borne γ-ray detector system employed consisted of a NaI(Tl) crystal and photomultiplier assembly, with a ^{241}Am "light-pulser" that provided a sharp inflight calibration line at an equivalent γ-ray energy of 2.68 MeV. The balloon flight was on December 2, 1970 from Hyderabad. (UK)

18622 NEUTRINO PROCESSES IN THE LEPTON ERA OF THE UNIVERSE AND HOT BIG BANG COSMOLOGY. Ray, D. (Presidency Coll., Calcutta). J. Phys., A (London); 5: No. 1, L17-18(Jan 1972).

The neutrino interactions in the lepton era of the Universe were studied according to the photon–neutrino coupling theory. It was found that neutrinos were decoupled from electrons from the beginning of the Universe and remained so throughout the lepton era of the Universe in hot big-bang cosmology. (auth)

Planetary Phenomena

Refer also to abstract 18503.

18623 HYDROGEN AND HELIUM AT HIGH TEMPERATURES. Trubitsyn, V. P. (Inst. of Earth Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 4, 639-42(Jan-Feb 1972).

Translated from Astron. Zh.; 48: No. 4, 810-14(Jul-Aug 1971).

The thermal dissociation and ionization of hydrogen and helium gases were investigated for conditions approximating the adiabatic models of Jupiter and Saturn. The dissociation constant for a weakly nonideal H_2 gas was calculated, allowing for the anharmonic vibrations of the atoms and the temperature dependence of the specific heat. The dissociation and ionization zones in the (p,T) diagram were determined for H and He. The possibility that the material in the cores of Jupiter and Saturn may be dissociated and partially ionized is discussed. (auth)

18624 PROCEEDINGS OF THE SECOND LUNAR SCIENCE CONFERENCE, HOUSTON, TEXAS, JANUARY 11–14, 1971. VOLUME 1. MINERALOGY AND PETROLOGY. Levinson, A. A. (ed.). Geochimica et Cosmochimica Acta, Supplement 2. Cambridge, Mass.; Massachusetts Institute of Technology Press (1971). 1003p. $25.00. (CONF-710102-(Vol.1)).

The purpose of the conference was to present the findings of some 175 principal investigators and their coworkers who have been engaged in studying Apollo 11 and 12 lunar rocks and soil samples and the results of the lunar-surface experiments conducted by the astronauts during their two missions to the Moon.

This volume covers the mineralogy and petrology of the samples. A paper by Vinogradov on the Luna 16 sample is also included. (W.D.M.)

18625 PROCEEDINGS OF THE SECOND LUNAR SCIENCE CONFERENCE, HOUSTON, TEXAS, JANUARY 11–14, 1971. VOLUME 2. CHEMICAL AND ISOTOPE ANALYSES. ORGANIC CHEMISTRY. Levinson, A. A. (ed.). Geochimica et Cosmochimica Acta, Supplement 2. Cambridge, Mass.; Massachusetts Institute of Technology Press (1971). 975p. $25.00. (CONF-710102-(Vol.2)).

This volume contains the papers dealing with chemical analysis, isotopic analysis, and organic chemistry of the Apollo 11 and 12 samples. (W.D.M.)

18626 PROCEEDINGS OF THE SECOND LUNAR SCIENCE CONFERENCE, HOUSTON, TEXAS, JANUARY 11–14, 1971. VOLUME 3. PHYSICAL PROPERTIES. SURVEYOR III. Levinson, A. A. (ed.). Geochimica et Cosmochimica Acta, Supplement 2. Cambridge, Mass.; Massachusetts Institute of Technology Press (1971). 875p. $25.00. (CONF-710102-(Vol.3)).

This volume contains the papers dealing with the physical properties of Apollo 11 and 12 samples and eleven papers on materials from the Surveyor III craft. (W.D.M.)

18627 AGE OF A LUNAR ANORTHOSITE. Husain, Liaquat; Schaeffer, Oliver A.; Sutter, John F. (State Univ. of New York, Stony Brook). Science; 175: No. 4020, 428-30(28 Jan 1972).

The crystallization age of an Apollo 15 anorthosite rock, 15415,9, returned from the lunar highlands was measured to be $(4.09 \pm 0.19) \times 10^9$ years. The primitive lunar crust must have been formed in the first 300 to 400×10^6 years. The results give some credence to the hypothesis that the primitive lunar surface was molten and large-scale fractional crystallization occurred in the early history of the Moon. (auth)

18628 APOLLO 15 LUNAR SAMPLES: A PRELIMINARY DESCRIPTION. Science; 175: No. 4020, 363-75(28 Jan 1972).

Samples returned from the Apollo 15 site consist of mare basalts and breccias with a variety of premare igneous rocks. The mare basalts are from at least two different lava flows. The bulk chemical compositions and textures of these rocks confirm the previous conclusion that the lunar maria consist of a series of extrusive volcanic rocks that are rich in iron and poor in sodium. The breccias contain abundant clasts of anorthositic fragments along with clasts of basaltic rocks much richer in plagioclase than the mare basalts. These two rock types also occur as common components in soil samples from this site. The rocks and soils from both the front and mare region exhibit a variety of shock characteristics that can best be ascribed to ray material from the craters Aristillus or Autolycus. (auth)

18629 GEOLOGIC SETTING OF THE APOLLO 15 SAMPLES. Science; 175: No. 4020, 407-15(28 Jan 1972).

The samples and photographs returned from the Apollo 15 site show that Hadley Delta is largely underlain by breccias whose clasts are mainly fragments of coarse-grained feldspathic rocks and nonmare-type basalt. Conspicuous sets of lineaments, visible in surface and orbital photographs of Mount Hadley and Hadley Delta, may represent systematic layering or fracture sets. The mare surface, with regolith about 5 meters thick, is underlain by two major basalt types, at least one of which has extensive lateral continuity and is exposed in the upper wall of Hadley Rille. Gradual erosional recession of the edges and filing of the interior of the rille by talus has contributed to the present cross sectional profile. (auth)

18630 CHEMISTRY, GEOCHRONOLOGY, AND PETROGENESIS OF LUNAR SAMPLE 15555. Chappell, B. W.; Compston, W.; Green, D. H.; Ware, N. G. (Australian National Univ., Canberra). Science; 175: No. 4020, 415-16(28 Jan 1972).

Lunar sample 15555 is a mare type basalt generally similar in chemical composition to the Apollo 12 basalts. Sample 15555 is older than any Apollo 12 basalt but younger than the Apollo 14 basalts analyzed thus far. (auth)

18631 ^{40}Ar–^{39}Ar DATING OF APOLLO SAMPLE 15555. Alexander, E. C. Jr.; Davis, P. K.; Lewis, R. S. (Univ. of California, Berkeley). Science; 175: No. 4020, 417-19(28 Jan 1972).

An age of $3.33 \pm 0.05 \times 10^9$ years was obtained for Apollo 15 sample 15555 by ^{40}Ar–^{39}Ar dating. The age of rock 15555, a basalt from the rim of Hadley Rille, establishes an upper limit to the age of the rille. The basalt flows filling the Hadley Rille section of the Imbrium basin postdate the formation of the basin—as measured by the Apollo 14 samples of the Fra Mauro formation—by at least 500×10^6 years. Therefore, the mare basalts cannot be simple impact melts but rather must result from some igneous activity on the Moon. (auth)

18632 RUBIDIUM–STRONTIUM AND POTASSIUM–ARGON AGE OF LUNAR SAMPLE 15555. Rama Murthy, V.; Evensen, N. M.; Jahn, Bor-ming; (and others) (Univ. of Minnesota, Minneapolis). Science; 175: No. 4020, 419-21(28 Jan 1972).

The lunar mare basalt 15555 from the edge of Hadley Rille was dated at 3.3×10^9 years by both rubidium–strontium and potassium–argon techniques. Age and trace element abundances closely resemble those of the Apollo 12 mare basalts. Data from lunar basalts obtained thus far indicate that they cannot be derived by simple fractionation from a homogeneous source. (auth)

18633 RARE-GAS RECORD IN THE LARGEST APOLLO 15 ROCK. Marti, K.; Lightner, B. D. (Univ. of California, San Diego, La Jolla). Science; 175: No. 4020, 421-2(28 Jan 1972).

The spallation krypton data from rock chip 15555,23 indicate a well-shielded location during most of the time during which the rock was exposed to cosmic rays. A krypton–krypton exposure age $81 \pm \frac{17}{11} \times 10^6$ years is calculated, and the gas retention ages are estimated. No evidence for the presence of products from ^{244}Pu or ^{129}I was found. (auth)

18634 GAS-RETENTION AND COSMIC-RAY EXPOSURE AGES OF LUNAR ROCK 15555. Podosek, F. A.; Huneke, J. C.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Science; 175: No. 4020, 423-5(28 Jan 1972).

The last lava flow in the Hadley Rille area of Mare Imbrium, as inferred from an ^{40}Ar–^{39}Ar experiment on a plagioclase separate from the lunar basalt 15555, occurred $3.31 \pm 0.03 \times 10^9$ years ago. An ^{40}Ar–^{39}Ar experiment on a whole rock sample shows significant loss of radiogenic ^{40}Ar and yields a well-defined, high-temperature plateau indicating a lower age of $3.22 \pm 0.03 \times 10^9$ years. A cosmic-ray exposure age of $90 \pm 10 \times 10^6$ years is determined from the ratio of spallogenic ^{38}Ar to calcium. (auth)

18635 GEOCHEMISTRY OF APOLLO 15 BASALT 15555 AND SOIL 15531. Schnetzler, C. C.; Philpotts, John A.; Nava, David F.; Schuhmann, Shuford; Thomas, Herman H. (Goddard Space Flight Center, Greenbelt, Md.). Science; 175: No. 4020, 426-8(28 Jan 1972).

Major and trace element concentrations were determined by atomic absorption spectrophotometry, colorimetry, and isotope dilution in Apollo 15 mare basalt 15555 from the Hadley Rille area; trace element concentrations were also determined in plagioclase and pyroxene separates from basalt 15555 and in soil 15531 from the same area. (W.D.M.)

18636 MINERALOGIC AND PETROLOGIC STUDY OF LUNAR ANORTHOSITE SLIDE 15415,18. Hargraves, R. B.; Hollister, L. S. (Princeton Univ., N. J.). Science; 175: No. 4020, 430-2(28 Jan 1972).

The anorthosite slide 15415,18 contains >98% subhedral plagioclase (97 mole % anorthite), two pyroxenes: diopsidic augite (46% wollastonite, 39% enstatite, 16% ferrosilite) with subsidiary (100) lamellae and grains of hypersthene (2.5% wollastonite, 58% enstatite, 39.5% ferrosilite), and traces of ilmenite. The pyroxene occurs interstitial to, and as small grains enclosed within plagioclase. The textures and compositions of the phases appear compatible with an origin by concentration and adcumulus growth of plagioclase from a gabbroic anorthosite (or hyperaluminous) magma in a "plutonic" environment. (auth)

18637 LUNAR ANORTHOSITE 15415: TEXTURE, MINERALOGY, AND METAMORPHIC HISTORY. James, Odette B. (Geological Survey, Washington, D. C.). Science; 175: No. 4020, 432-6(28 Jan 1972).

Lunar anorthosite 15415 consists almost entirely of anorthite (homogeneous anorthite 96.6 molecule %), with accessory diopsidic augite and traces of hypersthene, ilmenite, and a silica mineral. The rock has had a complex metamorphic history. The texture reflects at least two episodes of shearing (followed by intense and partial recrystallization, respectively), one episode of cataclastic deformation, and one or more episodes of shattering and fragmentation. (auth)

18638 APOLLO 15 GEOCHEMICAL X-RAY FLUORESCENCE EXPERIMENT: PRELIMINARY REPORT. Adler, I. (Goddard Space Flight Center, Greenbelt, Md.); Trombka, J.; Gerard, J.; (and others). Science; 175: No. 4020, 436-40(28 Jan 1972).

Although only part of the information from the x-ray fluorescence geochemical experiment has been analyzed, it is clear that the experiment was highly successful. Significant compositional differences among and possibly within the maria and highlands were detected. When viewed in the light of analyzed lunar rocks

and soil samples, and the data from other lunar orbital experiments (in particular, the Apollo 15 gamma-ray spectroscopy experiment), the results indicate the existence of a differential lunar highland crust, probably feldspathic. This crust appears to be related to the plagioclase-rich materials previously found in the samples from Apollo 11, Apollo 12, Apollo 14, Apollo 15, and Luna 16. (auth)

18639 PRIMORDIAL RADIOELEMENTS AND COSMOGENIC RADIONUCLIDES IN LUNAR SAMPLES FROM APOLLO 15. O'Kelley, G. Davis (Oak Ridge National Lab., Tenn.); Eldridge, James S.; Schonfeld, E.; Northcutt, K. J. Science; 175: No. 4020, 440-3(28 Jan 1972).

Two basalts, two breccias, and two soils from Apollo 15 were analyzed by nondestructive gamma-ray spectrometry. The concentrations of potassium, thorium, and uranium in the basalts were similar to those in the Apollo 12 basalts, but the potassium: uranium ratios were somewhat higher. Primordial radioelements were enriched in the soils and breccia, consistent with a two-component mixture of mare basalt and up to 20% foreign component (KREEP). The abundance patterns for cosmogenic radionuclides implied surface sampling for all specimens. The galactic cosmic-ray production rate of ^{48}V was determined as 57 ± 11 disintegrations per minute per kilogram of iron. Cobalt-56 concentrations were used to estimate the intensity of the solar flare of January 25, 1971. (auth)

18640 VARIATION OF HIGHEST CUTOFF FREQUENCY OF THE Io-CONTROLLED JOVIAN DECAMETRIC RADIATION. Goertz, C.; Haschick, A. (Rhodes Univ., Grahamstown, S. Afr.). Nature (London) Phys. Sci.; 235: No. 57, 91-4(31 Jan 1972).

It is stated that most recent theories regarding the Jovian decametric radiation deal entirely with the effect of Io on the radiation. In order to investigate maximum cutoff frequency variation, however, it is found necessary to make a distinction between Io-controlled radiation and radiation over which Io has no control. Only with this distinction can a comparison between theoretical predictions and observations be relevant. What is meant by "Io-controlled radiation" is defined, and analysis of data from microfilm records of Boulder HAO observations is discussed, covering 1961 to 1967. It is concluded that the variation of highest cutoff frequency with Io λ III is entirely restricted to the Io controlled radiation, and it can be interpreted in terms of a change in the height above Jupiter's surface at which the highest cutoff frequency occurs. The variation of the height of emission provides an interesting problem for theories to explain. It is also concluded that the unipolar theory of Goldreich and Lynden-Bell (Astrophys. J., 156: 59(1969)) does not give a satisfactory explanation of the observed maximum frequency variation. (UK)

18641 INTERACTION OF SOLAR AND GALACTIC COSMIC-RAY PARTICLES WITH THE MOON. Reedy, R. C.; Arnold, J. R. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 77: No. 4, 537-55(1 Feb 1972).

The rates of formation of radionuclides as a function of depth in the Moon are calculated for bombardments by galactic-cosmic-ray particles and by solar protons. The fluxes and spectra of galactic-cosmic-ray particles and of solar protons as a function of depth in the Moon are first determined semiempirically. For galactic cosmic rays, the model emphasizes the production of secondary particles and the attenuation of particles by nuclear interactions. Solar proton calculations cover a range of observed spectral parameters. Here, only ionization energy losses need be considered. The excitation functions for the nuclear reactions used in these calculations are presented. The calculated production rates are given for a range of depths in the Moon and are compared with experimental results and with earlier calculations. The model can also be applied to other effects of particle bombardment. (38 references) (auth)

18642 CALCULATION OF THE LUNAR PHOTON ALBEDO FROM GALACTIC AND SOLAR PROTON BOMBARDMENT. Armstrong, T. W. (Oak Ridge National Lab., Tenn.). J. Geophys. Res.; 77: No. 4, 524-36(1 Feb 1972).

The lunar photon albedo due to cosmogenic and primordial photon sources was calculated. The individual photon leakage spectra from prompt photons produced by galactic cosmic ray (GCR) and solar cosmic ray (SCR) induced nuclear interactions, from the decay of GCR- and SCR-induced radionuclides, and from the decay of naturally occurring radionuclides are given. An approximate estimate of the leakage from the photon-electron cascade initiated by the decay of neutral pions is also given. Monte Carlo methods were used to determine the nucleon-meson cascade, and discrete-ordinates methods were used for the photon and low-energy neutron transport. 39 references. (auth)

18643 LUNAR FOSSIL MAGNETISM AND PERTURBATIONS OF THE SOLAR WIND. Sonett, C. P.; Mihalov, J. D. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res.; 77: No. 4, 588-603(1 Feb 1972).

Perturbations of the solar wind downstream of the Moon and lying outside of the rarefaction wave that defines the diamagnetic cavity are used to define possible source regions comprised of intrinsically magnetized areas of the Moon. A map of the Moon is constructed showing that a model in which the sources are exposed to the grazing solar wind during the lunation yields a selenographically invariant set of regions strongly favoring the lunar highlands over the maria. An alternative model with the source due to electromagnetic induction is explored. The ages of the field sources should be consistent with those based on the basalt ages and possibly far older if the sources are connected with the formation of the highland rocks themselves. The perturbations are tentatively identified as weak shock waves, and a Mach angle in accord with nominal values for the solar wind is found. (50 references) (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 18494, 18689, and 19521.

18644 (AD-731056) LOCAL-TIME SURVEY OF PLASMA AT LOW ALTITUDES OVER THE AURORAL ZONES. Frank, L. A.; Ackerson, K. L. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Aug 1971. Contracts N00014-68-A-0196-0003; NAS5-10625. 45p. NTIS.

A local-time survey of the low-energy proton and electron intensities precipitated into the Earth's atmosphere over the auroral zones during periods of magnetic quiescence was constructed by selecting a typical, individual satellite crossing of this region in each of eight local-time sectors from a large library of similar observations with the polar-orbiting satellite Injun 5. (auth) (USGRDR)

18645 (AD-731095) PROGNOSTICATION OF IONOSPHERIC ELECTRON CONTENT. VOLUME I. Final Report. Waldman, Helio; da Rosa, Aldo V. (Stanford Univ., Calif. Stanford Electronics Labs.). Aug 1971. Contract F04701-70-C-0233. 98p. (SU-SEL-71-46; SAMSO-TR-71-82(Vol.1)). NTIS.

Two methods are described for the prognostication of the ionospheric electron content to be used in the correction of ranging measurements made by the users of System 621B. One method is based on the generation of coefficients of electron-content expansion as a function of the time of day, the day of the year, and of an index of solar activity. This expansion permits the estimation of the electron content at a given number of reference locations. The electron content at another location is obtained by means of a geographical extrapolation. The second method, an extension of the first, attempts to improve the prognosticated values by an updating technique that uses near real-time measurements of electron content made at some convenient location. Procedures for the implementation of the prognostication methods within the framework of System 621B are suggested. An error analysis for prognostication of the electron content over the North American area is presented. (auth) (USGRDR)

18646 (AD-731096) PROGNOSTICATION OF IONOSPHERIC ELECTRON CONTENT. VOLUME II. Final Report. Waldman, Helio; da Rosa, Aldo V. (Stanford Univ., Calif. Stanford Electronics Labs.). Aug 1971. Contract F04701-70-C-0233. 251p. (SU-SEL-71-47; SAMSO-TR-71-82(Vol.2)). NTIS.

The report contains the 4 appendices to Volume 1, AD-731095. The titles are the following: data processing; list of progress reports; additional investigations of "Fourier series-solar/geophysical activity index" algorithms; and tables of evaluation results. (USGRDR)

18647 (AD-731157) HF ELECTRON-DENSITY MEASUREMENTS UNDER PROJECT BIRDSEED. Schneible, Richard A.; Wilson, Frederick C. (Rome Air Development Center, Griffiss AFB, N. Y.). Sep 1971. 16p. (RADC-TR-71-167). NTIS.

The experiment plan, equipment, data collection, and reduction procedures used in the RADC hf sounding experiment carried out under AEC Project BIRDSEED are described. This experiment was designed to measure the electron density produced by high-altitude barium releases. Time histories of the electron density produced by releases SAPSUCKER and TITMOUSE are presented. They are of an order of magnitude smaller in magnitude than produced by various releases of comparable size. They also show a different characteristic shape. (auth) (USGRDR)

18648 (AD-731174) BEHAVIOR OF THE F REGION ABOVE NORTH AMERICA DURING THE MAGNETIC DISTURBANCE OF MAY 28, 1970. Environmental Research Papers. Rush, Charles M. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 10 Aug 1971. 23p. (AFCRL-71-426; AFCRL-ERP-370). NTIS.

The electron-density distribution of the F region above the North American continent is studied in detail during a magnetic disturbance that occurred on May 28, 1970. Using profiles deduced from vertical incidence ionograms recorded at 11 ionosonde locations, it is seen that the maximum electron density, the height of the maximum density, and the semi-thickness of the F region are severely modified during the course of the disturbance. The behavior of the ionosphere during the most disturbed phase of the magnetic storm is such that the disturbance associated effects are seen over the entire continent. The recovery of the ionosphere toward normal conditions does not show the same spatial extent, however. It is seen that the rate at which the ionosphere above a specific location recovers depends not only on the latitude but also the longitude of the location. This would seem to indicate that there is much local control in the behavior of the ionosphere during the recovery portion of a magnetic storm. (auth) (USGRDR)

18649 (AD-731400) SIMULATION OF NATURAL AND ENHANCED RADIO AURORAS. Final Report, July 31, 1970-September 30, 1971. Coleman, James T. (Battelle Memorial Inst., Columbus, Ohio). Sep 1971. Contract DASA01-69-C-0144. 93p. NTIS.

The objective is to develop, from laboratory simulations of the D and E regions of the atmosphere, a model to represent the cross section and attenuation effects induced by natural and nuclear-induced auroral formations. The program performed in FY 70 demonstrated the capability developed at Battelle's Columbus Laboratories for the scaled simulation of the natural aurora. The extension of the capabilities of the FY 70 system will include very intense, overdense auroras, auroras that would decay with time to better represent the radar effects produced by the equivalent of a nuclear-induced aurora. Wide-range ethalpy sweeps permitted the generation of a decaying magnetoactive scaled D-region simulation whose electron density varied from 10^{11} to 10^{9} electrons/cm^3. A large portion of the program in FY 71 was devoted to the development of equipment that would survive in the 5000°K environment. After considerable effort, all systems were extended in capability to permit steady-state operation. Initial forward-scatter and backscatter data were accumulated. A static auroral simulation facility was used to make fine-grain measurements of the buildup of auroral backscatter for various altitude regimes. For the simulated upper D region, strong backscatter effects due to an auroral electrojet were measured. The cross sections were considerably enhanced as the electrojet level was increased and evidence of nonlinear coupling between modes observed. A theory for the prediction of the cross-section buildup due to an auroral-electrojet system is given. (USGRDR)

18650 OBSERVATIONS OF F-REGION VERTICAL VELOCITIES AT MILLSTONE HILL. III. DETERMINATION OF ALTITUDE DISTRIBUTION OF H^+. Evans, J. V. (Massachusetts Inst. of Tech., Lexington); Holt, J. Radio Sci.; 6: No. 10, 855-61(Oct 1971).

Measurements of the vertical flux of O^+ in the F region were made by the incoherent scatter technique at Millstone Hill. Evidence was presented for the existence of fluxes of $\geq 10^8$ cm^{-2} sec^{-1} into the protonosphere during the day. The altitude variation of the O^+ flux was employed to infer the magnitude of the proton flux in the charge-transition region. From continuity considerations and the theory of minor ion diffusion in the topside of the F layer, an attempt was made to determine the abundance of H^+ in the altitude interval where it is a minor ion. The results indicate that the abundance of neutral hydrogen near 600 km must exceed about 10^5 cm^{-3}. However, the absence of detectable amounts of H^+ in the signal spectra taken near 1000 km indicates that the transition altitude must be above 1000 km and in turn the neutral-hydrogen abundance cannot exceed this estimate by more than a factor of 3. (auth)

18651 OBSERVATIONS OF F-REGION VERTICAL VELOCITIES AT MILLSTONE HILL. II. EVIDENCE FOR FLUXES INTO AND OUT OF THE PROTONOSPHERE. Evans, J. V. (Massachusetts Inst. of Tech., Lexington). Radio Sci.; 6: No. 10, 843-54(Oct 1971).

The vertical flux of O^+ in the F region was obtained from incoherent scatter radar measurements at Millstone Hill. An investigation is reported of the altitude variation of the flux during two 24-hour periods in March taken a year apart. It is found that, except for a brief period around sunrise, the flux is always directed downwards at altitudes below 500 km and its magnitude seems governed simply by the competing processes of production, loss, and diffusion. On the quiet day, above 535 km, the flux is directed upward in the afternoon when the electron density is not changing with time. This upward flux reached a peak value of $\sim 10^8$ ions cm^{-2} sec^{-1} near 700 km and then decreased at higher altitudes. This decrease is attributed to charge exchange with hydrogen. During the night on this day there is evidence for a downward flux of 3×10^7 O^+ ions cm^{-2} sec^{-1} from the protonosphere. Additional H^+ ions may be diffusing through the 1000-km level and contributing to the maintenance of the nighttime F layer, but they would not be detected in these observations. On the disturbed day there is no evidence of a flux of ionization into the protonosphere except at sunrise. It is suggested that this change is brought about by a large reduction in the abundance of neutral hydrogen, resulting from increased escape either via the polar wind or from the heat-

ing of the atmosphere in the vicinity of the auroral zones. Thus, it is suggested that the abundance of neutral hydrogen at the base of the exosphere is reduced at high altitudes during magnetic storms. (auth)

18652 REFLECTION OF PULSES FROM A LINEARLY VARYING IONOSPHERE MODEL WITH A VERTICAL MAGNETIC FIELD. Hill, D. A.; Wait, J. R. (Univ. of Colorado, Boulder). Radio Sci.; 6: No. 11, 933-7(Nov 1971).

The reflection of a linearly polarized plane electromagnetic wave by an idealized cold-plasma ionosphere model, with a constant vertical magnetic field, is examined. A linear electron density profile and a constant collision frequency are assumed. For vertical incidence, the exact time-harmonic solution for the parallel and cross-polarized reflected fields is expressible in terms of Airy functions. Then, using a numerical inverse Fourier transform, the impulse response of the model is obtained. It is shown that causality is satisfied for both the in-polarized and the cross-polarized component of the reflected transient wave. The cross-polarized component owes its existence to the presence of the dc magnetic field. (auth)

18653 NEW DYNAMIC ASPECTS OF INTERTROPICAL F2 IONIZATION. Vila, Paul (Centre National des Etudes de Telecommunications, Issy-les-Moulineaux, France). Radio Sci.; 6: No. 11, 945-55(Nov 1971).

Diurnal changes in F2 ionization distribution as measured during June and July 1966 over the Tamanrasset meridian reveal two types of asymmetric phenomena distorting the crest-and-trough system (formerly known as the equatorial F2-ionization anomaly). The first type corresponds to a general time variation of the latitude asymmetry. Observations yield four independent parameters of this asymmetry; for 80% of the time, the variation can be attributed to ion drag due to a time-varying meridian air wind. Magnetic activity is correlated with the amplitude of this wind, and the low-altitude thermospheric circulation is discussed. Day-to-day fluctuations of the diurnal evolution pattern suggest a possible long-term control of the equatorial electric field by the general dynamo current system. A second type of asymmetry shows more intense, local, and short-lived phases super-imposed on the fountain and neutral wind fluctuations. It has the character of a transistory forced-diffusion process. It is believed that the factor responsible is electron-temperature gradients produced by conjugate photoelectron heating. (auth)

18654 REDISTRIBUTION OF IONIZATION IN THE AURORAL AND EQUATORIAL IONOSPHERE. Closs, R. L. (Univ. of Otago, Dunedin, N. Z.). Radio Sci.; 6: No. 11, 939-43(Nov 1971).

It is shown that the electric fields that can exist in the auroral and equatorial ionospheres should produce a convergent flow of metallic ions. It is suggested that this convergent flow of ions is responsible for some of the sporadic E with high f_bE_s observed in these regions. It is further suggested that the existence of meridional currents in the equatorial ionosphere might be detected by their production of sporadic E, whereas in the auroral ionosphere the direction of the electric field and the molecular weight of the ions responsible for the E, layer can be found from height measurements and the separation between the striations in the sporadic layer. (auth)

18655 ADMITTANCE OF DIPOLAR RF PROBES IN A SIMULATED IONOSPHERE. Hall, T. A.; Landauer, G. (European Space Research Inst., Frascati, Italy). Radio Sci.; 6: No. 11, 967-80(Nov 1971).

A laboratory investigation of two types of dipolar rf admittance probes that could be of use in the ionosphere and inner magnetosphere is described. Simple theoretical models are presented, using the quasi-static approximation and vacuum sheath. Independent accurate measurements of both the electron density and temperature are made, using Langmuir probes and the dispersion properties of Bernstein waves, and the results are compared with the rf-probe predictions. In general, good agreement is obtained, indicating both the usefulness of the probes as a way of measuring electron densities in space and the applicability of the model used. These results also give an estimate of the effective sheath thickness around the probe, which is smaller than previous measurements have suggested. (auth)

18656 SEARCH FOR AN IONOSPHERIC DYNAMO CURRENT EFFECT OF THE GALACTIC X-RAY IONIZATION. Campbell, W. H. (Environmental Research Labs., Boulder, Colo.). Planet. Space Sci.; 20: No. 1, 61-71(Jan 1972).

An ionization contribution from galactic x-ray stars may contribute to a measurable night-time dynamo current modulation which could cause a consistent and measurable sidereal time variation of the geomagnetic field at the Earth's surface. A selection of magnetic records for the period 1964 through 1966 from a group of stations widely distributed in latitude was used to search for a quiet galactic component, G_q, of the measured field. If the seasonal contribution to the data is sufficiently suppressed, the results of the study indicate a diurnal, sidereal time variation in H of about 0.7 to 1.3 γ with opposite phase in the two hemispheres and a maximum value near noon in the north. The Z variation shows 0.4 to 1.3 γ diurnal change with minimum values near noon in both hemispheres. (auth)

18657 6300 Å QUANTUM EFFICIENCY OF THE RECOMBINATION MECHANISM IN THE NIGHT-TIME F LAYER. Brown, Walter E.; Steiger, Walter R. (Univ. of Hawaii, Honolulu). Planet. Space Sci.; 20: No. 1, 11-24(Jan 1972).

Simultaneous airglow and electron-content measurements made at Hawaii are used to infer the number of 6300- and 6364-Å quanta produced per electron lost in the nighttime F layer of the ionosphere. The equation of continuity of electrons is then solved numerically to obtain the electron-density profile, and the amount of quenching is estimated. This leads to the number of excitations of $O(^1D)$ per O_2^+ recombination (ϵ). It is found, for an exospheric temperature of 1100°K, $\epsilon = 1.1 \pm 0.6$, in good agreement with Zipf's laboratory measurement at 300°K. It is found that the number of $O(^1D)$ produced per electron lost at 300 km is 0.5 ± 0.1. (auth)

18658 EFFECT OF ION–ELECTRON COLLISIONS ON THE MOTION OF AN ION CLOUD. Giles, M. J. (Univ. of Sussex, Brighton, Eng.). Planet. Space Sci.; 20: No. 1, 25-40(Jan 1972).

The effect of ion–electron collisions on the motion of an ion cloud in a magnetoactive plasma immersed in a uniform external electric field E is examined. It is shown that ion–electron collisions reduce the velocity of the ion cloud by a factor that increases with the maximum initial plasma density N. The deformation of the ion cloud which results from the dependence of the fluid velocity on the plasma density n is examined. It is shown that a discontinuity in n occurs after a time $t_c \propto (EN)^{-1}$. The equation of the path of the discontinuity in the x–t plane is derived, and approximate expressions giving the magnitude of the discontinuity as a function of time are obtained. The width of the discontinuity is estimated by allowing for diffusion. The present results show that when ion–electron collisions are taken into account higher estimates of the ionospheric electric field strength are obtained from observations of the motion of artificial ion clouds. (auth)

18659 PARALLEL STUDY OF 6300 Å AIRGLOW EMISSION AND IONOSPHERIC SCINTILLATIONS. Mullaney, H. (Boston Univ.); Papagiannis, M. D.; Noxon, J. F. Planet. Space Sci.; 20: No. 1, 41-6(Jan 1972).

During periods of enhanced ionospheric scintillations, fluctuations in the intensity of the 6300-Å O I airglow line are considerably higher than during periods of low scintillation activity. The power spectrum of the enhanced 6300-Å fluctuations exhibits a f^{-1} dependence in the frequency range 10^{-4} to 10^{-3} Hz; from this a white spectrum is inferred for the corresponding fluctuations in F-region plasma density. There is no systematic enhancement in the intensity of the red line during periods of enhanced scintillations. On the basis of the present data, it is not possible to choose between particle precipitation and travelling compressional waves as the cause of the ionospheric irregularities and the associated red-line fluctuations. (auth)

18660 STUDY OF THE STRUCTURE OF ELECTRICAL CONDUCTIVITIES AND THE ELECTROSTATIC FIELD WITHIN THE EQUATORIAL ELECTROJET. Subbaraya, B. H.; Muralikrishna, P.; Sastry, T. S. G.; Prakash, Satya (Physical Research Lab., Ahmedabad, India). Planet. Space Sci.; 20: No. 1, 47-52(Jan 1972).

Simultaneous measurements of the electron density and the electrojet current intensity made from rocket-borne Langmuir probes and proton precession magnetometers flown from Thumba (magnetic dip 0°47'S) were used to study the structure of the electrical conductivities and the electrostatic field within the equatorial electrojet in the Indian zone. The results reveal that in this height region the horizontal electric field is not constant with height and most probably increases with increase in height. (auth)

18661 INTENSITY RATIO I(5577)/I(4278) AND THE EFFECTIVE LIFETIME OF $O(^1S)$ ATOMS IN PULSATING AURORA. Brekke, Asgeir; Henriksen, Kjell (Auroral Observatory, Tromsoe, Norway). Planet. Space Sci.; 20: No. 1, 53-60(Jan 1972).

The intensity ratio I(5577)/I(4278) in pulsating aurora and the effective lifetime of the $O(^1S)$ atoms was calculated for a large number of cases in Tromso during the winter 1969/70. Both the intensity ratio and the effective lifetime are found to depend on an energy parameter deduced from simultaneous observations of auroral intensity at 4278 Å and auroral absorption at 27.6 MHz. The effective lifetime is also found to have a significant distribu-

tion in the (0.6 to 0.9) sec interval. True diurnal variations are found in the effective lifetime possibly due to changes in the energy of the primary particles during the night. (auth)

18662 POSSIBILITY OF SUPERSONIC PLASMA FLOW IN A COLLAPSING POST-SUNSET IONOSPHERE. Fontheim, Ernest G. (Univ. of Michigan, Ann Arbor); Banks, P. M. Planet. Space Sci.; 20: No. 1, 73-80(Jan 1972).

As a result of the rapidly decreasing pressure in the topside ionosphere during twilight hours, a rapid downward flow of hydrogen plasma from the protonosphere takes place. In the case of steady state, isothermal, frictionless flow the criteron for the existence of a critical point (transition to supersonic flow) above 1000 km is that the plasma temperature be lower than a certain limiting temperature T_l which is a function of the field line considered. In the latitude region between 40 and 70° this upper temperature limit varies from 963 to 1066°K. Since these temperatures are considerably lower than the observed temperatures, it follows that in the case of steady state, isothermal flow the velocities will always remain subsonic. When the effect of the neglected terms is examined, the temperature gradient is shown to exert the strongest influence on the nature of the flow. For each latitude there is shown to exist a certain gradient $(\partial T/\partial r)_0$ such that, if $\partial T/\partial r < (\partial T/\partial r)_0$, the criterion for a critical point to exist above 1000 km is again that the temperature at the critical point be less than some limiting temperature T_l. If, however, $\partial T/\partial r > (\partial T/\partial r)_0$, then the criterion turns out to be that the temperature at the critical point be larger than T_l. The values of $(\partial T/\partial r)_0$ are between 9×10^{-6}°K cm^{-1} and 6.75×10^{-6}°K cm^{-1} for latitudes between 40 and 70°. For values of the temperature gradient above about 4×10^{-6}°K cm^{-1} the criterion is satisfied for physically realistic temperatures (above 1500°K), i.e., a critical point may exist above 1000 km. On this basis it is concluded that there is a definite possibility that supersonic downward flows in a post-sunset topside ionosphere may occur. (auth)

18663 PROTON MEASUREMENTS WITH THE SATELLITE AZUR DURING THE SOLAR PARTICLE EVENTS OF MARCH 5-13, 1970. Kirsch, E.; Muench, J. W. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Planet. Space Sci.; 20: No. 1, 89-101(Jan 1972).

Proton measurements by two large area GM-counters (threshold energies $E_p > 12$ MeV and $E_p > 30$ MeV) on board the polar satellite GRSA/AZUR during the solar particle events of March 5 to 13, 1970 are compared with similar measurements aboard Pioneer 8, HEOS A1, Explorer 41, and ATS 1. The solar-proton event on March 7 and 8 is discussed in view of diffusion and convection transport theories. During the growth phase of the event a diffusion theory is applicable with a diffusion coefficient $\bar{D} = 2 \times 10^{20}$ to 8×10^{20} cm^2/sec. The decay phase is explained by a convective transport process and adiabatic deceleration in a spherically expanding solar wind. During the strong geomagnetic storm on March 8 energetic storm protons are observed followed by a large decrease of the flux of protons with energies $E < 30$ MeV. The transmission of protons with energies $E < 30$ MeV from interplanetary space into the magnetosphere varies between 60 and 90%. Entry of protons into the magnetosphere is discussed using the interplanetary magnetic field and proton measurements of the HEOS A1 satellite, together with the proton measurements of the other satellites. The results can best be explained in terms of a widespread merging of interplanetary and Earth magnetic fieldlines. The protons appear to have direct access to the polar cap when the fields are antiparallel. (auth)

18664 SPACE EXPERIMENTS WITH BARIUM CLOUDS. Lust, R. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). New Sci.; 53: No. 779, 154-7(20 Jan 1972).

In a continuing investigation of the Earth's ionosphere and magnetosphere, striking results were achieved by releasing artifical barium clouds to trace out the conformation of the electric fields in space. The development of the method for creating artificial plasma clouds in space is described and the mechanism of the drift of the cloud examined. Results of barium cloud experiments which gave data about the electric fields in the ionosphere, providing new insight into the electric-current system in the low, mid, and high magnetic latitudes and into the perturbations of the Earth's magnetic field, are discussed. (UK)

18665 CHARACTERISTICS OF SMALL-SCALE E_s AND E IRREGULARITIES OVER IRKUTSK. Pezhemskaya, M. D. Ionos. Issled.; 17: 179-85(1969). (In Russian).

The parameters characterizing the small-scale inhomogeneity structure and drift in the E_s and E layers on the frequency 2.2 MHz for 1964-1965 are discussed. The data were treated by correlation analysis and statistical methods. The most probable velocities of drift lay in the range of 60 to 80 m/s and are directed toward N-E and S-W for both layers. These data are in good agreement with those of other investigators of the E region. (Meteorol. Geoastrophys. Abstr.)

18666 VERTICAL VELOCITY IN THE E-REGION OF THE IONOSPHERE AND FORMATION OF ELECTRON DENSITY IRREGULARITIES. Vohra, Kiran; Misra, K. D.; Singh, R. N. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 9: No. 10, 837-40(Oct 1971).

The continuity equation governing electron-density distribution in the E region of the ionosphere was solved to study the distribution of vertical velocity. The rocket measurement of electron density was used to estimate the altitude of sporadic-E layer formation. The conditions for the formation of large- and small-scale irregularities were worked out. It is concluded that the enhanced current flow in the lower ionosphere is associated with the formation of the electron-density irregularities. (auth)

18667 DETERMINATION OF VELOCITY AND DIRECTION OF MOVEMENT OF LARGE E_s FORMATIONS BY THE PLAN-POSITION-INDICATOR SOUNDING METHOD. Aleksandrova, L. V. Ionos. Issled.; 17: 175-9(1969). (In Russian).

A description of the equipment for backscatter sounding on frequency 17.1 MHz with the plan-position indicator (PPI) is given. Techniques for determination of the velocities and directions of movements of very large-scale irregularities in the E_s layer using d't records, with different bearing obtained after special coping sequences of PPI records, are described. (Meteorol. Geoastrophys. Abstr.)

18668 PITCH-ANGLE DISTRIBUTIONS OF 100- TO 300-keV PROTONS MEASURED BY THE ESRO IB SATELLITE. Amundsen, R.; Soeraas, F.; Lindalen, H. R.; Aarsnes, K. (Univ. of Bergen). J. Geophys. Res.; 77: No. 4, 556-66(1 Feb 1972).

The pitch-angle distribution of 100- to 300-keV protons in the early morning/late afternoon local magnetic-time sector has been studied by using data from the early lifetime of the Esro IB (Boreas) satellite. The pitch-angle distribution is described as a function of invariant latitude for different geomagnetic activity levels. On the nightside, going poleward, the particle fluxes were found to peak at 90°, followed by a latitude range with isotropy. On the dayside, two precipitation zones were found during slight disturbances, the poleward zone showing an isotropic pitch-angle distribution and the equatorward zone showing an anisotropic distribution peaked at 90°. During disturbed conditions, the two zones merge and the region of isotropic pitch-angle distribution expands. The particle loss cones were determined and compared with theoretical loss cones in a realistic field model. (auth)

18669 TRAVELING IONOSPHERIC DISTURBANCE AS A DIAGNOSTIC TOOL FOR THERMOSPHERIC DYNAMICS. Yeh, K. C. (Univ. of Illinois, Urbana). J. Geophys. Res.; 77: No. 4, 709-19(1 Feb 1972).

Some observational results are reported of traveling ionospheric disturbances. The experiment continuously monitors the wave polarization of signals transmitted by the geostationary satellite ATS 3. One year of single-station data has been compiled for synoptic study. When observed at three stations, in addition to the period of the wave, the horizontal phase velocity can be determined. An attempt has been made to link the experimentally determined ionospheric parameters with the neutral atmospheric parameters by using a crude theory. The result suggests that a better theory should be developed so that the diagnosis of these thermospheric parameters can be made by making traveling disturbance observations. In doing so, many previously ignored factors should be re-examined, especially the effect produced by high thermospheric winds. (34 references) (auth)

18670 RADIO-AURORAL ASPECT SENSITIVITY AND THE TWO-STREAM INSTABILITY. Moorcroft, D. R. (Univ. of Western Ontario, London). J. Geophys. Res.; 77: No. 4, 765-8(1 Feb 1972).

Farley's two-stream instability theory of 1963 has been used to explain the vhf radar reflections from small-scale irregularities in the equatorial electrojet obtained at angles up to about one degree away from perpendicularity to the magnetic-field direction. Much larger departures from orthogonality are observed in radio aurora and have been considered to be a difficulty in applying Farley's theory to radio-auroral observations. One suggestion for explaining these large departures from orthogonality has been that the auroral electrojet currents are sufficiently intense to change locally the direction of the magnetic field by several degrees. An additional possibility is explored, considering the auroral electrojet current motions sufficiently great not only to introduce some distortion in the magnetic field, but also to substantially increase the maximum deviation from orthogonality permitted by Farley's mechanism. These two effects are then combined to give an approximate indication of how the aspect sensitivity should vary with current strength and direction. Ob-

servations made of magnetospheric convective motion applicable to the E-region electron-drift velocity are discussed. It appears that electron–ion relative drift velocities of several km s^{-1} are a regular occurrence in the auroral E region. Some estimates of how the overall aspect sensitivity might vary with drift velocity and with orientation relative to the current direction are studied. (J.C.W.)

18671 VERTICAL GRADIENTS IN THE THEORY OF RADIO AURORA. Moorcroft, D. R. (Univ. of Western Ontario, London). J. Geophys. Res.; 77: No. 4, 769-72(1 Feb 1972).

The mechanism responsible for the formation of irregularities in radio aurora was investigated. The mechanism of vertical density gradients has been previously applied as the cause of type-II irregularities in the equatorial electrojet. This study also deals with the possibility that vertical gradients might modify the aspect sensitivity of radio auroral reflections coming from two-stream instability irregularities. Such an effect would not be expected at the magnetic equator, where the magnetic field is essentially perpendicular to the direction of any vertical gradients, but could be of importance in the auroral zone. Both of these effects are applied in a single calculation, which incorporates vertical gradients into the two-stream instability theory. The simple fluid equation approach adopted is compared with Farley's kinetic calculation to establish the validity of the relatively simple expressions obtained, and is used to show that, at the most, vertical gradients will affect the directions for growth of two-stream instability waves by less than 1°. It is then shown that the mechanism of Rogister and D'Angelo (J. Geophys. Res., 75: 3879(1970)) cannot operate even at the magnetic equator. It is concluded that, although some of the results of the simple fluid equation approach are only qualitatively correct, many of the gross characteristics of the instability are reproduced with sufficient accuracy to be useful, and the results will be correct in order of magnitude. (J.C.W.)

18672 THRESHOLD OF IONOSPHERIC MODIFICATIONS BY RADIO WAVES. Weinstock, Jerome; Bezzerides, Bandel (Aeronomy Lab., Boulder, Colo.). J. Geophys. Res.; 77: No. 4, 761-4(1 Feb 1972).

The amount of incident transmitter power necessary to effect modification of the ionosphere or threshold was investigated by increasing steps above some arbitrary low level and the modifications noted at each step. The fact that the ionosphere is changing during the time it takes to vary the steps is a drawback. This letter points out that: (a) a simpler and quicker method exists for measuring the threshold transmitter power, and this measurement can be made in a single run, or step, with an ionosonde; (b) this method determines the precise altitude at which modification begins, as well as the threshold, and; (c) this measurement has already been made and requires a theoretical analysis to deduce the information from an ionogram. The basis of the method is to let the ionosphere vary the power instead of manually varying the incident power at the ground. It is a matter of locating the lowest frequency on an ionogram trace at which anomalous absorption is evident and then using this frequency to calculate $|E_{thr}|$ and $|E_{max}|$ from wave swelling formulas. (J.C.W.)

18673 F-REGION BEHAVIOR ABOVE NORTH AMERICA DURING THE MAGNETIC DISTURBANCE OF MAY 28, 1970. Rush, Charles M. (Air Force Cambrige Research Labs., Bedford, Mass.). J. Geophys. Res.; 77: No. 4, 757-60(1 Feb 1972).

Results were analyzed of the electron-density variation in the F region for a period of time surrounding the geomagnetic disturbance that started gradually about 2000 UT on May 27, 1970 and grew to be of moderate intensity with a maximum deviation of 174 γ in the horizontal component of the geomagnetic field observed at Fredericksburg, Virginia. Observations during the disturbance show that, although the onset of the disturbance effects is large in spatial extent, the recovery of the ionosphere to its normal or near-normal state appears to depend on local conditions. The general behavior of the F region over North America is shown in which hourly values of f_0F2 are used for May 27–29, 1970. Data were also accumulated at Hanover, Boulder, Wallops Island, and Vandenburg. (J.C.W.)

18674 SYSTEMATICS IN AURORAL ENERGY SPECTRA. Eather, R. H. (Boston Coll., Chestnut Hill, Mass.); Mende, S. B. J. Geophys. Res.; 77: No. 4, 660-73(1 Feb 1972).

There is a systematic increase in the mean energy of auroral electrons as the total precipitated energy increases. The change in λ 4278 N_2^+ intensity from ~50 R to ~10 kR (i.e., IBC 2^+) correlates better with the change in mean energy of the precipitating electrons than with the change in number flux. Nightside aurora that exhibit this property superimpose on a wide region of soft (≲1 keV) precipitation that extends from the equatorial boundary of aurora to well poleward of normal visible aurora. On the dayside, the soft "cusp" precipitation generates the statistical oval, although there may be larger energy inputs equatorward of the oval. (auth)

18675 COMPARISON OF VERY-LOW-FREQUENCY AURORAL HISS WITH PRECIPITATING LOW-ENERGY ELECTRONS BY USE OF SIMULTANEOUS DATA FROM TWO OGO 4 EXPERIMENTS. Hoffman, R. A. (Goddard Space Flight Center, Greenbelt, Md.); Laaspere, Thomas. J. Geophys. Res.; 77: No. 4, 640-50(1 Feb 1972).

Recent satellite observations have shown that "auroral hiss," covering the frequency range from a few kHz to several hundred kHz, is a common phenomenon in polar regions. To deduce the origin of this hiss, the records of a vlf experiment (0.3 to 18 kHz) with simultaneous data obtained by an auroral-particle experiment having detectors for precipitating electrons at 0.7, 2.3, and 7.3 keV, were compared. It is found that, on the dayside of the Earth, the occurrence of vlf hiss correlates well with precipitation events at 0.7 keV, but in general very poorly with activity in the higher-energy channels. Exact correlation between variations in vlf hiss intensity and in electron fluxes is rare even at 0.7 keV. In addition, vlf hiss tends to be observed over a somewhat larger spatial region than precipitating 0.7-keV electrons. It is concluded that, on the dayside, auroral hiss is generated by soft (E < 1 keV) "cusp region" electrons and that the lack of detailed correlation between the two phenomena is caused by propagation effects as the hiss travels downward and spreads from the generation region. Further study is required of observations made on the nightside, where vlf hiss may correlate with fluxes of harder electrons. (auth)

18676 MEASUREMENT OF THE WAVE-NORMAL VECTOR OF PROTON WHISTLERS ON Ogo 6. Chan, King-wang; Burton, Rande K.; Holzer, Robert E. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 4, 635-9(1 Feb 1972).

The first experimental determination of the wave-normal vector of proton whistlers in the ionosphere is described. Between the crossover frequency and the proton gyrofrequency, both right-hand and left-hand modes of propagation can occur for upgoing waves. Theoretically, the amount of energy in the respective modes depends on θ, the angle between the wave normal and the magnetic field. For proton whistlers with only left-hand mode energy between the crossover and proton gyrofrequency, θ ranged from 36 to 51°. For proton whistlers with strong right-hand and left-hand mode signals, θ ranged from 24 to 29°. The result is in good agreement with Wang's [(1971) NSA 25: 16947] collisionless mode-coupling model. The angle between the wave normal and the vertical is found to increase with increasing altitude. (auth)

18677 BALLOON OBSERVATIONS OF SIMULTANEOUS AURORAL X RAY AND VISIBLE BURSTS. Hofmann, D. J.; Greene, R. A. (Univ. of Wyoming, Laramie). J. Geophys. Res.; 77: No. 4, 776-80(1 Feb 1972).

Simultaneous auroral x-ray and visible bursts were recorded on a balloon at about 5 gm/cm^2 atmospheric depth over Fort McMurray, Alberta, Canada, on April 12, 1971. The observation that the visible emission in the bursts starts earlier and ends later than the x rays can be explained as emanating from (a) a uniform precipitating electron-intensity variation or (b) a precipitating electron spectral change. Events that have been observed or discussed previously are analyzed for possibly explaining that the observed bursts, negligibly delayed in the visible emissions relative to the x-ray emission, demand a nonmonotonically increasing electron spectrum to maintain the concept of an equatorial modulation or acceleration site. (J.C.W.)

Effects of Nuclear Detonations

18678 IONOSPHERIC DISTURBANCES CAUSED BY NUCLEAR EXPLOSIONS. Kotadia, K. M.; Jani, K. G. (Gujarat Univ., Ahmedabad, India). J. Inst. Telecommun. Eng.; 15: No. 3, 167-83(1969).

Results of studies on the effects in the lower and upper atmosphere of some nuclear explosions are reported. The explosions were carried out somewhere near Novaya Zemlya in the USSR during the later half of 1962. The study shows that two types of disturbance, short-period acoustic waves and long-period gravity waves, are propagating over long distances from the original blast. The initial disturbance at all levels in the atmosphere is caused by a short-period fundamental acoustic wave. The oscillations that follow in ground-level pressure have decreasing periods from 5.5 to 2 min, and they die out in about an hour. The oscillations produced in ionospheric electron densities have in some cases decreasing periods and in others increasing periods varying from 100 to 45 min and they persist for the whole daytime. The short-period disturbance (<10 min) is the acoustic mode of a traveling wave and the long-period disturbance (>30 min) is treated as a gravity wave. The study of true height profiles of electron density from lower boundary of the E layer up to the height of maximum

electron density of the F2 layer has revealed some characteristic features that cannot be explained by existing theories on traveling-wave disturbances. It is suggested that the factors such as (1) coupling between charged and neutral particles, (2) interaction with the Earth's magnetic field, and (3) local irregularities should be taken into account for adequacy of the theory to explain the ionospheric changes. 21 references. (Indian Sci. Abstr.)

18679 HYDROMAGNETIC WAVES LAUNCHED BY AN EXPANDING METALLIC SPHERE. Holway, Lowell H. Jr. (Raytheon Research Div., Waltham, Mass.). J. Geophys. Res.; 77: No. 4, 726-9(1 Feb 1972).

R. F. Lutomirski's model for the generation of hydromagnetic waves by a conducting sphere that expands with a step-function velocity is generalized to include an arbitrary expansion velocity. The radiation field is calculated for an exponential variation of velocity and for a snowplow velocity of the ionized debris, which are more representative of the velocity field due to a nuclear explosion. The maximum radiated electric field is shown to be considerably lower for the smooth velocity variations than for the discontinuous velocity variation. (auth)

Particle Kinetics and Trapping

Refer also to abstracts 18652, 18663, 18664, and 18670.

18680 STABILITY OF AN ELECTRON BEAM INJECTED ALONG THE GEOMAGNETIC FIELD. Alekhin, Yu. (Inst. of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Moscow); Karpman, V. I.; Ryutov, D. D.; Sagdeev, R. Z. Cosmic Electrodyn.; 2: No. 3, 280-91(Oct 1971).

The dynamics of an electron beam injected into the magnetospheric plasma was investigated. The beam structure was considered theoretically and the dispersion in space of the beam is given. Instabilities of the beam were considered near the point of injection both for cold and warm cases. Kinetic instabilities of the beam were also investigated and the conditions of stability and instability are given for both high and low altitudes. (auth)

18681 DEFORMATION OF THE DUSKSIDE PLASMA-PAUSE. Nishida, Atsuhiro (Tokyo Univ.). Cosmic Electrodyn.; 2: No. 3, 340-9(Oct 1971).

The sharp westward edge of the plasmapause bulge frequently detected by the whistler method was examined by using the geomagnetic data in the dusk sector as a measure of the magnetospheric convection activity in the bulge region. It was found that the detection of the above feature is invariably associated with the increase in the northward geomagnetic disturbance field on the duskside. This suggests that the sharp westward edge develops as the tip of the bulge is twisted sunward as the magnetospheric convection directed toward the Sun is intensified. (auth)

18682 INTERPLANETARY ORIGIN OF ELECTRIC FIELDS IN THE MAGNETOSPHERE. Nishida, Atsuhiro (Tokyo Univ.). Cosmic Electrodyn.; 2: No. 3, 350-74(Oct 1971).

Correlation analysis between the activity of polar magnetic disturbances and condition of the interplanetary magnetic field is summarized and the origin of the magnetospheric electric fields responsible for the disturbances is discussed. Two distinct kinds of disturbances are produced under the influence of the north-south component B_z of the interplanetary magnetic field. The first of these, DP 2, follows the state of B_z closely with a delay of 15 min or so, while the other, DP 1 (polar substorm), typically breaks up 1 to 2 h after the decrease in B_z. The results are discussed in the light of the reconnection model of the magnetosphere, and it is suggested that DP 2 is the immediate consequence of the penetration of the interplanetary electric field into the magnetosphere, while DP 1 follows the collapse of the field lines accumulated in the tail during the convection motion associated with the DP 2 electric field. (auth)

18683 GEOELECTRIC FIELD STRENGTHS AS DEDUCED FROM THE MID-FREQUENCY SLOPES OF PC1 HYDROMAGNETIC WHISTLERS. Offen, R. J. (Otago Univ., Dunedin, N. Z.). Planet. Space Sci.; 20: No. 1, 135-7(Jan 1972).

The sign of $d\bar{f}/dt$, the mid-frequency slope, measured from the 423 hydromagnetic whistler events recorded at Dunedin between Feb. 1967 and July 1969 for the local-time intervals 0000-0930, 0930-1700, and 1700-2400 are tabulated. From these results the average computed values of the geoelectric field for the three local-time incidence intervals are obtained. These values are seen to compare favorably with those derived from the frequency drifts of other types of magnetospheric emissions. (UK)

18684 MODEL OF A MAGNETIC FIELD IN THE GEOMAGNETOSPHERE. Alekseev, I. I.; Shabanskii, V. P. (Moscow State Univ.). Planet. Space Sci.; 20: No. 1, 117-33(Jan 1972).

A new magnetospheric field model is proposed. The magnetospheric surface is considered to be a tangential discontinuity and is approximated by a paraboloid of revolution. The magnetic field within the magnetosphere was obtained as a solution of the magnetostatics problem. This solution is the field of the internal sources (geomagnetic dipole and current sheet in the magnetospheric tail) summarized with the field of the magnetopause currents induced by the internal sources. The model makes it possible to obtain the magnetospheric field for an arbitrary inclination of the dipole axis to the Earth-Sun line and to include correctly the returning currents streaming over the magnetopause and caused by the neutral sheet in the magnetotail. (auth)

18685 KELVIN-HELMHOLTZ INSTABILITY OF THE EARTH'S MAGNETOPAUSE. Ong, R. S. B.; Roderick, N. (Univ. of Michigan, Ann Arbor). Planet. Space Sci.; 20: No. 1, 1-10(Jan 1972).

The effect of the finite thickness of the shear layer on the Kelvin-Helmholtz instability of the Earth's magnetopause boundary is investigated. The thickness of the layer stabilizes the boundary with respect to short wavelength perturbations, which were previously found to be unstable in the zero-thickness analysis. Compressibility effects further stabilize the layer. The effects of the magnetic field on the instability are also discussed. (auth)

18686 ASYMMETRY OF THE RING CURRENT. Troshichev, O. A.; Fel'dshtein, Ya. I. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 3, 374-7(May-Jun 1971).

Translated from Kosm. Issled.; 9: No. 3, 408-12(May-Jun 1971).

Measurements of ring-current protons made on September 8, 1966, on the OGO-3 satellite are compared with magnetic-field changes recorded at low-latitude and high-latitude stations. From 3-4 UT there was a depression of the magnetic field at the low-latitude stations in the evening and daylight sectors, associated with the appearance of ring-current protons in the evening sector at L = 4 to 6. Intense polar magnetic disturbances arise at high latitudes at the same time. The absence of protons in the daylight sector at 6-7 UT reflects temporal variations in the particle flux as a result of the fading of substorms. The field decrease at the Earth's surface at low latitudes does not always begin in the midnight sector, but sometimes near the evening meridian. (auth)

18687 ELECTRONS WITH ENERGIES $E_e > 7$ MeV AND $E_e > 15$ MeV IN THE INNER VAN ALLEN BELT. Savun, O. I.; Shavrin, P. I.; Tsaplin, V. S. Cosmic Res. (USSR) (Engl. Transl.); 9: No.3, 378-81(May-Jun 1971).

Translated from Kosm. Issled.; 9: No. 3, 413-17(May-Jun 1971).

A Cherenkov detector was used on the Kosmos 137 satellite to study fast charged particles in the inner belt. It is concluded from an analysis of the longitudinal dependences, a comparison of the fluxes detected with the altitude dependence of the atmospheric density, and from a comparison with the results obtained by an analogous detector 16 months later on Kosmos 219 that there are captured electrons with energies $E_e > 7$ MeV and $E_e > 15$ MeV that are primarily responsible for the detector count rate at $L > 1.2$. (auth)

18688 CHARACTERISTIC OSCILLATIONS OF THE GEOMAGNETIC TAIL. Ershkovich, A. I.; Nusinov, A. A. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 3, 430-3(May-Jun 1971).

Translated from Kosm. Issled.; 9: No. 3, 470-3(May-Jun 1971).

A realistic model of the magnetotail was studied. The assumed tail is a plasma cylinder with free boundaries immersed in the interplanetary plasma. The plasma is homogeneous, ideally conducting and incompressible, and the frozen-in magnetic field is homogeneous and parallel to the axis of the cylinder, z. The lines of force are assumed to be frozen-in at the ends of the cylinder in superconducting planes perpendicular to the z axis. The characteristic oscillations of the geomagnetic tail were investigated where the tail was considered as a plasma waveguide. In this model, the electromagnetic oscillations of the tail are determined only by its characteristic parameters and are not related to the solar-wind parameters. The excitations of oscillations of the tail, considered as a bundle of lines of forces in the presence of variations of the solar-wind speed, were previously studied. (J.C.W.)

18689 LIFETIME OF ELECTRONS IN THEIR INTERACTION WITH HISS-TYPE VLF EMISSIONS. Beloshitskii, V. V.; Burov, V. A.; Il'in, V. D. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 3, 434-7(May-Jun 1971).

Translated from Kosm. Issled.; 9: No. 3, 473-6(May-Jun 1971).

Data of simultaneous observations of the flux of energetic electrons precipitating from the region of the outer radiation belt and of hiss-type emission are presented. The lifetime of the particles,

determined by the pitch-angle diffusion in scattering at vlf waves, depends on the energy of the particles, the density of the cold plasma, the value of the magnetic field, and the spectral characteristics of the waves. It is assumed that the energy losses over the path from the lower boundary of the ionosphere to the Earth are insignificant and the intensity of the vlf emissions near the lower boundary of the ionosphere is the same as at the ground. Ground measurements of the intensity of vlf emission are presented. For the frequency range 1 to 10 kHz, the absorption in the ionosphere may be taken into consideration, using the geometrical optics approximation. The absorption over the path from the equatorial plane (the region of generation) to the ionosphere may be neglected. It is shown that the lifetime of electrons with energy ~250 keV is smaller than the duration of the hiss for G ~ 1, and electrons between 250 keV and 1 MeV can be catastropically precipitated out from the region of the outer radiation belt. (J.C.W.)

18690 CONJUGATE CONDUCTIVITY ASYMMETRY AND THE PRECIPITATION OF MAGNETOSPHERIC ELECTRONS. Catchpoole, J. R. (York Univ., Toronto). Aust. J. Phys.; 24: No. 6, 881-7(Dec 1971).

A simplified model of the atmosphere was used to calculate the wind-induced vertical redistribution of ions derived from the 100-km level. Assuming the effect to be dissimilar in magnitude at the conjugate point, a potential difference will be set up in this way between the ends of the magnetic-field line. For various values of the parameters involved, an estimate is made of the consequent precipitation to ionospheric heights of previously trapped electrons of the magnetosphere. (auth)

18691 HIGHLY ECCENTRIC: BUT RELEVANT. Stubbs, P. New Sci.; 53: No. 779, 151(20 Jan 1972).

The Satellite HEOS-A2 is a highly eccentric-orbit spacecraft that will probe the Earth's magnetosphere and adjoining interplanetary space at high latitude. It will investigate a region of near-space where theoreticians postulate that the northern of two magnetic neutral points should exist. Particular problems that HEOS-A2's seven experiments may help to resolve are: the origin of the trapped radiation belts; the way particles pass through the magnetosphere to reach low altitudes; how the interplanetary field reacts with the geomagnetic field; and the mechanism that creates and accelerates auroral particles. (UK)

18692 TRIGGER DELAY IN WHISTLER PRECURSORS. Dowden, R. L. (Univ. of Colorado, Boulder). J. Geophys. Res.; 77: No. 4, 695-9(1 Feb 1972).

Detailed dispersion analysis of about thirty precursor events showed that the associated long whistlers traveled in the plasmasphere, at L ~ 2.5 to 3.8, and probably in the same duct as their precursors. Measurement of the f, t trigger points of the precursors showed that the time of triggering (t) was generally more than halfway between the initiating lightning flashes and the associated two-hop whistlers by an amount (Δt) that generally decreased with trigger frequency (f). Because of apparent objections to triggering by hybrid whistlers, three alternative explanations are investigated. Since all these are subject to serious objections, the hybrid explanation is re-examined. It is shown that the hybrid signal is expected to be quite weak (and hence rarely, if ever, observed) and that weak trigger signals should give, according to R. A. Helliwell's 1967 theory, both a delay and a frequency shift that account for the observed trigger points quite well. (auth)

18693 HIGH-TIME RESOLUTION OF LOW-LATITUDE ASYMMETRIC DISTURBANCE IN THE GEOMAGNETIC FIELD. Crooker, Nancy Uss (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 4, 773-5(1 Feb 1972).

The low-latitude asymmetric disturbance field was studied by Crooker and Siscoe (Radio Sci., 6: 495(1971)) by performing Fourier harmonic analyses on hourly values of magnetic records from eight stations. At low latitudes the magnitude and location of maximum depression of the asymmetric field are well represented by the amplitude G and the hour angle of local time φ of the first harmonic. For data from the IGY it was shown that G ranges from 10 γ to over 100 γ and φ tends toward 1800 LT during disturbed times. The time variation of G was shown to be similar to that of the AE index; the correlation coefficient between the two parameters for data from July, 1957, through Nov., 1959, is 0.68. Other investigators have also noted correlations between their asymmetry parameters and AE. Results of the same Fourier analyses are reported here, but 2.5-min instead of hourly values are used. Substorm activity, which has a time scale of 1 to 2 hours, can be studied in detail using the higher time resolution. Two features illustrated are that, although the average position of φ is 1800, it is seen to respond relatively systematically to the AE index and that the time lag of maximums in G is behind those in AE. An interpretation of the time lag between G and AE and of the response of φ to AE in terms of storm morphology is not obvious, and previous experiments are discussed. (J.C.W.)

18694 INTERPLANETARY SECTOR STRUCTURE AT SOLAR MAXIMUM. Wilcox, John M. (Univ. of California, Berkeley); Colburn, David S. J. Geophys. Res.; 77: No. 4, 751-6(1 Feb 1972).

The observed interplanetary magnetic sector structure during 1969 was obtained with the Ames Research Center magnetometers on Explorer 33 and 35. The observed mean photospheric magnetic field and the interplanetary sector polarity inferred from polar geomagnetic observations are additional data for direct comparisons from Pioneer 9 data since the 1969 experiments. The interplanetary sector pattern has now survived solar maximum without appreciable disruption from the increased levels of solar activity. During the 1969 period, the pattern consists broadly of two sectors per solar rotation with occasional smaller sectors. One of the most prominent persistent boundaries is the change from toward polarity to away polarity that occurs near the 27th day of the Bartels rotation from rotations number 1855 to 1862. The average position of the recurring boundary is very nearly a vertical line on the Bartels chart, corresponding to a 27-day recurrence period. Another prominent recurring boundary is the change from away to toward polarity. This boundary is seen first on Jan. 6 and last on Dec. 9. It may be assumed that the boundary near the 27th day of the Bartels-rotation interval has little or no proper motion and corresponds to rotation with a 27-day period. A comparison was made of the observed interplanetary magnetic sector pattern during 1969 with a sector polarity pattern inferred from observations of polar geomagnetic activity. A comprehensive view of the interplanetary sector structure from 1962–1969 is tabulated. (J.C.W.)

18695 SOME CHARACTERISTICS OF LOW-FREQUENCY OSCILLATIONS OBSERVED AT ATS 1. Cummings, W. D. (Grambling Coll., La.); Mason, F.; Coleman, P. J. Jr. J. Geophys. Res.; 77: No. 4, 748-50(1 Feb 1972).

Low-frequency oscillations of the magnetic field at ATS 1 were analyzed for the 25-month data interval December 1966 to December 1968. Irregular oscillations and oscillations associated with magnetic storms were excluded from the analysis. Of the 222 events identified, 170 events were oscillating predominantly transverse to the background magnetic field. The oscillations were observed to occur most frequently in the early afternoon hours. They also seemed to occur more frequently during December, January, and February than at other times of the year. During a given individual event the frequency was fairly constant and it varied between 1.5×10^{-3} and 20×10^{-3} Hz with a broad peak near 10×10^{-3} Hz. The event duration varied between a minimum of 10 min and a maximum of 14 hours and 26 min. During a given event the amplitude varied. The average maximum amplitude of an event was $\delta B \simeq 3\ \gamma$. (auth)

18696 SECULAR MAGNETIC VARIATION AND THE INNER PROTON BELT. Schulz, Michael; Paulikas, G. A. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 77: No. 4, 744-7(1 Feb 1972).

A comparison of characteristic time scales for the e-folding of proton energies suggests that the secular decrease of the geomagnetic dipole moment is a more important effect than radial diffusion over much of the inner zone. The secular effect should therefore be included in future theoretical analyses of inner-belt proton distributions. (auth)

18697 RESPONSE OF TRAPPED PARTICLES TO A COLLAPSING DIPOLE MOMENT. Heckman, Harry H. (Univ. of California, Berkeley); Lindstrom, Peter J. J. Geophys. Res.; 77: No. 4, 740-3(1 Feb 1972).

Particle motion in the secularly varying geomagnetic field is investigated in terms of a dipolar magnetic field with decreasing magnetic moment M. For dM/dt equal to the rate of decay of the earth's dipole component, we find there is drift in B–L space, resulting in an inward drift of particles accompanied with increased energy and unidirectional intensity. Secular variation of the geomagnetic field appears to be a dominant mechanism for radial drift in the inner radiation belt. (auth)

18698 DETERMINATION OF MAGNETOHYDRODYNAMIC SHOCK NORMALS. Abraham-Shrauner, Barbara (Washington Univ., St. Louis). J. Geophys. Res.; 77: No. 4, 736-9(1 Feb 1972).

A method for determining many new magnetohydrodynamic shock normal expressions is described that uses both magnetic-field and plasma-flow parameters. These shock normal expressions are useful as a check on the usual magnetic coplanarity expression or for cases in which the most reliable data are mixed. For high Alfvén Mach numbers, the exact results are well approximated by the simple velocity coplanarity formula.

This is illustrated by calculating shock normals for the 1965 bow shock crossing of Pioneer 6. (auth)

18699 RAPID ACCESS OF SOLAR ELECTRONS TO THE POLAR CAPS. Turtle, J. P. (Air Force Cambridge Research Labs., Bedford, Mass.); Oelbermann, E. J. Jr.; Blake, J. B.; (and others). J. Geophys. Res.; 77: No. 4, 730-5(1 Feb 1972).

Simultaneous measurements of solar electrons and protons in interplanetary space and in the magnetotail were made during the onset of the November 2, 1969, solar-particle event. These particle measurements, when compared with continuous transpolar vlf measurements on three propagation paths, indicate that the solar electrons have access to the magnetotail and north polar cap with a time delay τ such that $0 \lesssim \tau < 1$ min. (auth)

18700 SPATIAL CHARACTERISTICS OF MIDLATITUDE GEOMAGNETIC MICROPULSATIONS. Zelwer, Ruben; Morrison, H. F. (Univ. of California, Berkeley). J. Geophys. Res.; 77: No. 4, 674-94(1 Feb 1972).

Simultaneous recordings of geomagnetic micropulsations in the 0.001- to 1-Hz frequency range across the state of California were made in late 1967. Two orthogonal horizontal components of the magnetic field were measured at sites located near Berkeley, California, Reno, Nevada, and Fresno, California. The data from the Reno and Fresno sites were telemetered by telephone to the Berkeley site, where they were reported simultaneously with the Berkeley data in analog and digital form. Digital portions of the data were analyzed, and polarization and spectral characteristics were obtained by using a method based on the theory of quasi-monochromatic or partially polarized radiation. Depending on their spatial characteristics, micropulsations were classified into two basic types, uniform and nonuniform. Uniform micropulsations are in phase and nearly identical in amplitude and wave form at the three sites. They include Pi1's, Pi2's, Pc1's, and quiet-time Pc2–4's. The nonuniform micropulsations, which consist primarily of daytime Pc2–3's, exhibit substantial differences in amplitude, phase, and frequency content between the stations. A striking period increase with latitude was also observed. Examples of both uniform and nonuniform micropulsations are presented here. A reversal of the sense of rotation from counterclockwise in the morning hours to clockwise in the afternoon and evening hours with a transition occurring around noon local mean time was observed for all micropulsations. An attempt to explain the behavior of micropulsations in terms of current theories of hydromagnetic-wave propagation is made, and evidence for a narrow L-shell localization of micropulsations is presented. (57 references) (auth)

18701 DRIFT-SHELL SPLITTING AT ARBITRARY PITCH ANGLE. Schulz, Michael (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 77: No. 4, 624-34(1 Feb 1972).

Analytical expressions are developed to approximate the bounce period and second invariant as functions of particle energy, equatorial pitch angle, and parameters of the guiding field line. The equatorial pitch angle is not restricted to values near $\pi/2$, as in the harmonic-oscillator approximation, but terms indicating deviation of the magnetic field from that of a dipole are included to first order only. There follow approximate analytical expressions for tracing drift shells in the magnetosphere. Two important cases are considered separately: (a) shell splitting caused by dawn–dusk asymmetry of the magnetosphere's electrostatic potential, superimposed on a dipolar magnetic field, and (b) shell splitting caused by day–night asymmetry of the Earth's magnetic field in the absence of electric fields. In each case, an expression is derived for the ratio $D_{\alpha\alpha}/D_{pp}$, i.e., for the relationship between pitch-angle diffusion and radial diffusion in the presence of drift-shell splitting at arbitrary equatorial pitch angle. (25 references) (auth)

Solar Wind and Cosmic Ray Interactions

Refer also to abstracts 18643 and 18668.

18702 SPACECRAFT CHARGING AT SYNCHRONOUS ORBIT. DeForest, Sherman E. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 77: No. 4, 651-9(1 Feb 1972).

ATS 5 can charge to potentials as high as 10,000 volts during eclipse, and as high as 200 volts in sunlight. This charging has been used to infer the presence of the plasmasphere at synchronous altitude in the midnight region, and its prompt disappearance when hot plasma is injected in association with substorms. Although injected plasma has a density of $1.0/cm^3$, the remaining cold plasma (<50 eV) has a density of $0.01/cm^3$. A mathematical model of ATS 5 has been constructed that can be used to predict spacecraft potentials. In addition, parts of ATS 5 can charge to several hundred volts without affecting the overall spacecraft potential appreciably. (auth)

18703 IMP 5 MAGNETIC-FIELD MEASUREMENTS IN HIGH-LATITUDE OUTER MAGNETOSPHERE NEAR THE NOON MERIDIAN. Fairfield, D. H.; Ness, N. F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 4, 611-23(1 Feb 1972).

Imp-5 magnetic-field measurements at geomagnetic latitudes up to 75° and at distances beyond 6 R_E reveal the permanent existence of a broad depressed field region centered on the polar or dayside cusp. Field strengths at 7 R_E on cusp field lines that connect to the Earth are typically only 50 to 70% of that of an undistorted dipole field. The transition region between the magnetosheath and the point where the fields are clearly of dipolar origin is characterized by large-amplitude fluctuations and the lack of a clear magnetopause boundary. Magnetic-field perturbations are observed in the cusp region with magnitudes up to 45 γ and in directions that are approximately perpendicular to the average field. These perturbations are suggestive of field-aligned currents and their magnitudes are consistent with the low-altitude measurements obtained on polar-orbiting spacecraft. (34 references) (auth)

18704 OGO 5 MAGNETIC-FIELD DATA NEAR THE EARTH'S BOW SHOCK: A CORRELATION WITH THEORY. Guha, J. K.; Judge, D. L.; Marburger, J. H. (Univ. of Southern California, Los Angeles). J. Geophys. Res.; 77: No. 4, 604-10(1 Feb 1972).

Magnetic-field data obtained in the Earth's bow-shock region with a high-resolution triaxial fluxgate magnetometer aboard the Ogo-5 satellite have been correlated with a theory of Tidman and Northrop (NSA 22: 17464). These authors have shown that either of two hypotheses about the nature of low-frequency magnetic waves could be invoked to explain previous observations. Observed exponentially decaying upstream waves are consistent with only one of these hypotheses. This observation allows use of the theory to infer the local shock velocity and frequency of driving currents within the shock. This method of finding the shock velocity is less sensitive to errors in the plasma parameters than is the method based on the Rankine–Hugoniot relations. (auth)

18705 THEORY OF DISCRETE WAVE PACKETS IN THE SOLAR WIND. Wu, C. S. (Univ. of Maryland, College Park). J. Geophys. Res.; 77: No. 4, 575-87(1 Feb 1972).

Discrete wave packets were observed by Ogo 5 and earlier satellites. These waves were believed to be in the whistler mode. Since their group velocities were found to be smaller than the solar-wind speed, these waves could not have been generated in the bow shock and could not have propagated upstream later. The present theory discusses a mechanism similar to that of the echo phenomenon in plasma physics discovered in recent years. The present theory enables an explanation of (a) why the wave packets were associated with the bow shock, (b) why the wave packets were characterized by coherent oscillations, and (c) why the wave packets had group velocities smaller than the solar wind and yet could still occur in the solar wind. In short, the theory is able to interpret all the essential features deduced from the observational data. (auth)

18706 THREE-DIMENSIONAL SOLAR WIND. Suess, Steven T. (National Oceanic and Atmospheric Administration, Boulder, Colo.). J. Geophys. Res.; 77: No. 4, 567-74(1 Feb 1972).

A restricted three-dimensional model of the solar wind is studied by a perturbation technique with spherically symmetric boundary conditions. The results give the velocities and fields at 1 AU with an internal accuracy of about 1% and can be used to examine the accuracy and applicability of the results of previous calculations. Although only a polytropic gas is specifically treated, a simple consequence of the mathematics allows the azimuthal velocity to be calculated with great accuracy by using a conductive heat equation. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 19608 and 19620.

18707 CALCULATION OF ARGON ION SCATTERING FROM A COPPER (100) SINGLE CRYSTAL SURFACE. Shul'ga, V. I.; Yurasova, V. E. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.): 13: No. 8, 1867-71(Feb 1972).
Translated from Fiz. Tverd. Tela: 13: No. 8, 2224-9(Aug 1971).

Computer-calculated results of 30-keV Ar ion scattering from a copper single-crystal (100) surface for ion beam incidence on the (110) plane are presented. A binary model for ion collision with atoms of two crystal layers is used in the calculation. The scattered ion spatial distributions are calculated, both in the presence and in the absence of lattice vibrations. The calculated results are compared with experimental data. (auth)

18708 REMARK ON COOLING OF ATOMIC HYDROGEN BEAMS. Wilsch, H. (Physikalisches Institut, Erlangen, Ger.). J. Chem. Phys.; 56: No. 3, 1412-13(1 Feb 1972).

A procedure for providing liquid nitrogen cooling of an atomic hydrogen beam, without reducing the rf discharge and the dissociation degree in the discharge tube, is described briefly. The procedure is based on cooling only a portion of the tube (an exit region of 2-cm length) by a snug metallic shoe connected to a liquid nitrogen bath. (A.G.W.)

18709 SCATTERING OF ARGON BEAMS WITH INCIDENT ENERGIES UP TO 20 eV FROM A (111) SILVER SURFACE. Hays, W. J.; Rodgers, W. E.; Knuth, E. L. (Univ. of California, Los Angeles). J. Chem. Phys.; 56: No. 4, 1652-7(15 Feb 1972).

Angular scattering distributions for argon atoms incident on well-characterized epitaxially deposited (111) Ag surfaces were measured for incident-beam energies up to approximately 20 eV. The scattering pattern is a specularly directed single lobe. Its width increases as the incident-beam energy increases, as is expected for structural scattering. The direction of the maximum scattered signal is about 3° supraspecular for the entire energy range (3 to 18 eV) covered in these experiments. The expected increase of the scattered-beam peak amplitude with increase of beam energy is observed at the lower energies. A peak-amplitude decrease with beam-energy increase at higher beam energies is observed here for the first time. Bombardment of the surface with an argon beam with energy above an observed threshold energy reduced significantly the scattering-distribution width for a thermal-energy helium-beam probe. It is found that, at least under certain surface conditions, a high-energy argon beam is a more sensitive surface probe than is a thermal-energy helium beam. (auth)

18710 STUDY OF THE BEAM-FOIL EXCITATION MECHANISM USING $^4He^+$, $^6Li^+$, AND $^7Li^+$ PROJECTILES. Andersen, N.; Bickel, W. S.; Boleu, R.; Jensen, K.; Veje, E. (Univ. of Copenhagen). Phys. Scr.; 3: No. 6, 255-60(1971).

Beams of $^4He^+$, $^6Li^+$ and $^7Li^+$ ions accelerated to energies between 10 and 75 keV were sent through thin foils of beryllium, carbon, aluminum or gold, or into a helium gas target. The photon emission immediately after the foil was measured in the wavelength range 200 to 600 nm. Excitation functions were measured for 11 Li I^a spectral lines, 8 Li I^b lines, and 10 Li II^a lines. It was found that the excitation functions within one level scheme have similar slopes, whereas differences exist between excitation functions of different level schemes. From the excitation functions relative population functions have been constructed and it is found that the populations of Li I^a levels are proportional to the probability of getting neutral Li, whereas the He I, He II, Li I^b and the Li II^a population functions differ from the charge-state distribution curves. Comparisons between the population of corresponding levels in ^6Li and ^7Li indicate that the collision time is a more relevant parameter than the projectile energy. The statistical weights related to the orbital angular momentum and to the total spin of the electronic structure are found to influence the beam–foil interaction, whereas the statistical weight related to the nuclear spin is not apparent. The foil excitation is compared to single atomic collisions, and it is concluded that the beam–foil excitation is the result of a multicollision atomic interaction. Sputtered excited atoms of beryllium and aluminum were observed. (auth) (Sweden)

Atomic and Molecular Properties

Refer also to abstracts 18783, 18785, 18789, 18798, and 19348.

18711 INTERACTION POTENTIAL BETWEEN GROUND STATE HELIUM ATOM AND THE B $^1\Sigma_u^+$ STATE OF THE HYDROGEN MOLECULE. Schaefer III, Henry F.; Wallach, Daniel; Bender, Charles F. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 3, 1219-23(1 Feb 1972).

In order to aid in the interpretation of the energy-transfer experiments of Moore and co-workers, ab initio quantum mechanical calculations were carried out on the four-electron system ^1S He + B $^1\Sigma_u^+$ H_2. Nine C_{2v} geometries were considered, all involving a fixed H–H separation of 2.43 bohr. A contracted Gaussian basis of three s and two p functions on each atom was used, and calculations were performed including 1, 416, and 706 configurations. The 416-configuration calculation was designed to include only the electron correlation between He and H_2 and should yield the most reliable results. The 416-configuration calculation predicts a large van der Waals interaction between He and the lowest $^1\Sigma_u^+$ state of H_2. The potential curve has a well depth of cm^{-1} (0.05 eV) and this minimum occurs for a distance 3.72 bohr (1.97 Å) between He and the H_2 center of mass. Self-consistent-field calculations using the same basis and geometries were done on the He + X $^1\Sigma_g^+$ H_2 and He + b $^3\Sigma_u^+$ systems. The potential curves for these two states lie well below that of He + B $^1\Sigma_u^+$ H_2 for thermal energies and it is suggested that curve crossing with the two lower surfaces is not responsible for the observed quenching of the B $^1\Sigma_u^+$ H_2 fluorescence by He. (auth)

18712 QUANTUM-MECHANICAL INVESTIGATION OF THE HeH_2^+ ENERGY SURFACE. Benson, Merle J.; McLaughlin, Donald R. (Univ. of New Mexico, Albuquerque). J. Chem. Phys.; 56: No. 3, 1322-31(1 Feb 1972).

Results of an ab initio calculation of the potential surface of HeH_2^+ are reported, with emphasis on establishing the low energy reaction paths for $HeH^+ + H_2 = He + H_3^+$ within the single configuration molecular orbital (SCF) approximation. Using a basis set of (9s1p/4s1p) Gaussian functions centered on the (He/H) nuclei, the lowest potential-energy paths are found to follow C_{2v} symmetry, and these are examined in greater detail. A small number of configuration-interaction (CI) calculations are reported involving all single and double excitations from the single configuration. From these calculations about 80% of the total correlation energy (or 90% of the p limit correlation energy) is obtained for the separated two-electron fragments, and the CI surface is indicated to lie parallel to the SCF surface to within a few percent of the total energy change of the reaction. The C_{2v} minimal energy reaction path is found to decrease monotonically with no reaction barriers or local minima, with the heat of reaction (at 0°K) calculated to be 2.63 eV exothermic from the SCF results and 2.62 eV exothermic from the CI results. (auth)

18713 CURRENT STATUS OF THE ANALYSIS OF THE OPTICAL SPECTRA OF URANIUM. Steinhaus, D. W.; Radziemski, L. J. Jr.; Cowan, R. D. (Los Alamos Scientific Lab.). pp 151-63 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

New high-resolution spectroscopic systems and rapid precision data-reduction techniques are being used to produce a new description of the uranium spectra. The present line list contains information on about 25,000 lines, of which 13,000 have a wave number accuracy better than 0.01/cm. About 10,100 lines were classified to 1050 levels of U I and U II, but only a few of the levels were assigned to an electron configuration. Some theoretical calculations were made of the energy level structure of the low-lying configurations of U I through U VI. Agreement with known experimental levels of U I and U II is reasonably good for the lower levels. These calculations lead to ionization potentials for U I through U V which are, respectively, 6.22 ± 0.5, 10.6 ± 1, 18.9 ± 1, 32.1 ± 2, and 47.1 ± 2 V. 37 references. (auth) (STAR)

18714 POTENTIAL-BARRIER EFFECTS IN PHOTOABSORPTION. III. APPLICATION TO 4d-SHELL PHOTOABSORPTION IN LANTHANUM. Dehmer, J. L.; Starace, A. F. (Univ. of Chicago). Phys. Rev., B; 5: No. 5, 1792-6(1 Mar 1972).

An exploratory calculation of the photoabsorption cross section near the 4d ionization threshold of lanthanum metal is carried out.

The level structure of the configuration $4d^94f$ is found to be altered by interaction with the continuum configuration $4d^9\epsilon f$. The Fano profile of the resonance above threshold is calculated, as are the oscillator strengths of the discrete states below threshold. The results provide the ground work for more detailed calculations. (auth)

18715 POTENTIAL-BARRIER EFFECTS IN PHOTOABSORPTION. II. INTERPRETATION OF PHOTOABSORPTION RESONANCES IN LANTHANIDE METALS AT THE 4d-ELECTRON THRESHOLD. Sugar, Jack (National Bureau of Standards, Washington, D. C.). Phys. Rev., B; 5: No. 5, 1785-92(1 Mar 1972).

The resonances in the photoabsorption spectra of the lanthanides near the 4d absorption edge are interpreted as transitions of the type $4f^N4f^N \rightarrow 4d^94f^{N+1}$. Calculations of the $4d^94f^{N+1}$ energy levels and relative gf values for these transitions are shown to be in good agreement with the observed absorption spectra. The assumption that the lanthanides occur in trivalent form (with the exception of Eu and Yb) in the metallic solid state is confirmed by these results. (auth)

18716 POTENTIAL-BARRIER EFFECTS IN PHOTOABSORPTION. I. GENERAL THEORY. Starace, Anthony F. (Univ. of Chicago). Phys. Rev., B; 5: No. 5, 1773-84(1 Mar 1972).

Parts of the theories of spectroscopy, collisions, and autoionization are combined to provide a unified framework for a quantitative theory of experimental data on 4d-shell photoabsorption in rare earths. The calculations by atomic theory are intended for tentative application to solids. The theory should also apply to 3p-shell photoabsorption in the transition metals and to other cases where the effect of a potential barrier is crucial. A prescription is given for the ab initio numerical calculation of total and partial photoabsorption cross sections, as well as of the profiles, energies, and widths of resonances. A sum rule is derived for transitions of the type $l_1^{l_1}+^2l_f^N \rightarrow l_1^{l_1+1}l_f^{N+1}$, which yields the integrated strength of observed absorption spectra. (auth)

18717 CONCERNING THE FINE AND HYPERFINE STRUCTURE OF Lu I. Goebel, L. H. (Technische Univ., Berlin). Z. Naturforsch.; 26a: No. 10, 1559-62(Oct 1971). (In German).

By means of the level-crossing method, the hyperfine-structure constants and the lifetime as well as the angular momentum of the term 29607.98 cm^{-1} of Lu I were determined. This term can be assigned to the $6s^27p^2P_{\frac{3}{2}}$-state. The signs of the interaction constants were obtained by the investigation of the line 3376.5 Å from this state into the $5d6s^2\ ^2D_{\frac{5}{2}}$ ground state in a Fabry–Perot interferometer. Together with the measured branching ratio from the lifetime, the oscillator strengths were found. The results are: $J = {}^3/_2$; $B/|A| = 0.4947$ (4); $A = 678.94$ (2) gJ/1.24 MHz; $B = 335.9$ (3) gJ/1.24 MHz; $\tau = 0.512\ (16) \times 10^{-8}$ (1.24/gJ) s; f(3376.5 Å = 0.382 (15); f(3620.3 Å) = 0.15 (4) $\times 10^{-2}$. (auth)

18718 OPTICAL RESOLUTION OF THE LAMB SHIFT IN ATOMIC HYDROGEN BY LASER SATURATION SPECTROSCOPY. Haensch, T. W.; Shahin, I. S.; Schawlow, A. L. (Stanford Univ., Calif.). Nature (London) Phys. Sci.; 235: No. 56, 63-5(24 Jan 1972).

A successful attempt to eliminate Doppler broadening of the red Balmer line H_α of atomic hydrogen at 6563 Å by high resolution saturation spectroscopy using a repetitively pulsed narrow-band tunable dye laser. Revolution of the single fine structure components of H_α and observation of the Lamb shift directly in the optical absorption spectrum were achieved. The hydrogen was excited in a simple Wood discharge tube and no cooling was necessary. It was possible to observe the saturated absorption in the afterglow and thus to minimize Stark broadening and shifts due to electric fields in the plasma. (auth)

18719 GROUND STATE OF He_2 BY THE SPIN-OPTIMIZED METHOD. Kunik, Dan.; Kaldor, Uzi (Tel Aviv Univ., Israel). J. Chem. Phys.; 56: No. 4, 1741-5(15 Feb 1972).

The $^1\Sigma_g^+$ ground state of He_2 is investigated using the spin-optimized self-consistent-field (SOSCF) method. Molecular orbitals need not have g or u character. Over 40% of the correlation energy is included in the SOSCF function without giving up the concept of one orbital per electron, and a simple spin-coupling scheme, very close to maximal pairing, is obtained. Imposing symmetry restrictions on the orbitals leads to significantly higher energy and a more complicated coupling scheme. The dependence of orbitals on the internuclear distance is described. (auth)

18720 FOUR-CENTER EXPANSION FOR H_3^{2+}. Shoucri, Rashad M.; Darling, Byron T. (Univ. Laval, Quebec). J. Chem. Phys.; 56: No. 4, 1789-90(15 Feb 1972).

A four-center expansion is used for calculating potential-energy curves for H_3^{2+}. The three protons are assumed to form an equilateral triangle. Three 1s orbitals are placed, respectively, at the three summits of the triangle, and one 1s orbital is placed at the centroid of the triangle. Results show no stable bound state for this system. (A.G.W.)

18721 ADDENDUM TO RECALCULATION OF THE CROSSED-GRAPH CONTRIBUTION TO THE FOURTH-ORDER LAMB SHIFT. Fox, J. A. (Cornell Univ., Ithaca, N. Y. Univ. of Utah, Salt Lake City). Phys. Rev., D; 5: No. 2, 492-3(15 Jan 1972).

The discrepancy among the various calculations of the crossed-graph contribution to the fourth-order Lamb shift is discussed and resolved. (auth)

18722 OBSERVATION OF DOUBLE ELECTRON EXCITATION IN H_2 BY PHOTOELECTRON SPECTROSCOPY. Samson, J. A. R. (Univ. of Nebraska, Lincoln). Chem. Phys. Lett.; 12: No. 4, 625-7(15 Jan 1972).

Double electron excitation leading to dissociative photoionization of H_2 was observed at 247 Å. The results are explained as a transition into the repulsive $^2\Sigma_u^+$ state of H_2^+ with a probability of the order of 16% with respect to the production of ground-state ions. (auth)

18723 NEW APPLICATIONS OF THE LEAST-SQUARES METHOD: UNBOUND STATES OF HELIUM AND ASYMPTOTICALLY CORRECT BOUND STATES. Read, F. H. (Univ. of Manchester, Eng.). Chem. Phys. Lett.; 12: No. 4, 549-51 (15 Jan 1972).

Two new applications of the least-squares method are described, namely (i) in the calculation of the energies and wave functions of the unbound $2s^2\ ^1S$ and $2p^2\ ^1S$ states of He, and (ii) in the use (for the 2^1S, 3^1S, and 4^1S states of He) of basis set functions asymptotically correct to a high order. (auth)

18724 ELECTRON CORRELATION IN S STATES OF THE HELIUM ATOM. Sperber, Gunnar (Uppsala Univ.). Int. J. Quant. Chem., Symp.; No. 4, 127-30(1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

Results obtained to date in a study of spatial correlation in two-electron atomic systems are described. The behavior of the correlation fraction f as a function of r_2 for a provisionally fixed r_1 is discussed for the ground state and the 1s2s states of the helium atom. Autoionizing states are considered briefly. (A.G.W.)

18725 MANY-BODY APPROACH TO THE PROPERTIES OF INTERACTING ATOMS. II. Dutta, N. C.; Dutta, C. M.; Das, T. P. (Univ. of Utah, Salt Lake City). Int. J. Quant. Chem., Symp.; No. 4, 299-305(1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

The Brueckner–Goldstone many-body perturbation approach is applied to calculation of three-body interactions at long range. Results presented include van der Waals constants for three-body systems of helium, hydrogen, and neon atoms, coefficients for calculation of hyperfine constants for H–He and H–Ne systems, and static dipole polarizabilities of H, He, Li, and Ne. (A.G.W.)

18726 EXACT AND ASYMPTOTIC X-RAY INTENSITY VALUES FROM 20-PARAMETER HYLLERAAS-TYPE WAVE FUNCTIONS. He AND He-LIKE IONS. Benesch, Robert (Univ. of Waterloo, Ont.); Smith, Vedene H. Jr. Int. J. Quant. Chem., Symp.; No. 5, 35-45(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

X-ray form factors and total scattered x-ray intensity values, computed analytically from radial electron–nuclear and electron–electron distribution functions, $D_0(r)$'s and $P_0(r_{12})$'s, are presented for the ^1S ground states of H^-, He, Li^+, B^{3+}, O^{6+}, Ne^{8+}, and Mg^{10+}. The distribution functions are those obtained algebraically from the 20-parameter Hylleraas-type wave functions of Hart and Herzberg. Asymptotic total intensity values, which have been shown to depend on the derivatives of even order of $g(r_{12}) = P_0(r_{12})/r_{12}$, are in excellent agreement with those computed directly from $P_0(r_{12})$. The asymptotic values are listed only for He; numerical values of the derivatives $g^{(2)}(0)$, $g^{(4)}(0)$, $g^{(6)}(0)$, and $g^{(8)}(0)$ are given for He and the 2-electron ions. None of the wave functions studied here satisfy the Kato electron–nucleus cusp condition. (auth)

18727 DIPOLE PROPERTIES OF THE METASTABLE 2^3S STATE OF HELIUM. Dutta, C. M.; Dutta, N. C. (Univ. of Utah, Salt Lake City). Int. J. Quant. Chem., Symp.; No. 5, 59-66(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

The linked-cluster many-body perturbation theory is applied to investigation of the metastable 2^3S state of helium and its long-range interaction with the ground state of helium. Dynamic and static polarizabilities, dipole excitation energies, van der Waals constants, and hyperfine pressure shifts are reported. (A.G.W.)

18728 POTENTIAL CURVE FOR LINEAR SYMMETRIC H_3. Liu, B. (IBM Research Lab., San Jose, Calif. Univ. of Chicago). Int. J. Quant. Chem., Symp.; No. 5, 123-31(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

The configuration-interaction (CI) method is applied to calculate the potential curve for linear symmetric H_3. The configurations are constructed from pseudonatural orbitals in order to improve the convergence of the CI expansion. The computed barrier energy is 0.1 kcal. This is an upper bound and has a probable error of 0.5 kcal. The method used in this calculation is critically evaluated, and specifications of a projected calculation to reduce the error to less than 0.2 kcal are given. (auth)

18729 BOUNDS TO EXCITATION ENERGIES OF H IN THE PRESENCE OF LONG-RANGE DISPERSION FORCES. Abdulnur, Suheil F. (Univ. of Florida, Gainesville). Int. J. Quant. Chem., Symp.; No. 5, 169-74(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

Using a method based on inner projections and operator inequalities, techniques for finding upper and lower bounds to the long-range interaction constant are described. Bounds are presented for the effect of such an interaction on the transitions: $1s \rightarrow 2p_z$, $2s \rightarrow 3p_z$, and $1s \rightarrow 3p_z$ in H in the presence of a number of inert gas atoms in their ground states. The results show that the long-range forces cause a frequency red shift in all three transitions. This shift increases with increasing atomic number of the inert gas atom and is largest for the transition with the highest frequency among the various possible transitions between a considered set of states. (auth)

18730 SPIN–SPIN SPLITTING FACTORS FOR f^6 ELECTRON CONFIGURATIONS. Malli, Gulzari; Saxena, K. M. S. (Simon Fraser Univ., Burnaby, British Columbia). Int. J. Quant. Chem., Symp.; No. 5, 605-12(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

The spin–spin splitting factors (ρ) for f^6 electron configuration are evaluated and tabulated for general usage. These are used to evaluate the Hartree–Fock values of the splitting factors for $Sm(4f^6)$, $Sm^{++}(4f^6)$, $Eu^{+++}(4f^6)$, $Gd(4f^8)$, $Gd^{++}(4f^8)$, and $Tb^{+++}(4f^8)$ rare earth systems. (auth)

18731 SPIN–SPIN SPLITTING FACTORS FOR f^7 ELECTRON CONFIGURATIONS. Saxena, K. M. S.; Malli, Gulzari (Simon Fraser Univ., Burnaby, British Columbia). Int. J. Quant. Chem., Symp.; No. 5, 613-18(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

Expressions of the spin–spin splitting factors (ρ) for all the terms of f^7 electron configuration are evaluated and tabulated for general usage in the first-order perturbation calculations. The values of the splitting factors for $Eu(4f^7)$, $Eu^{++}(4f^7)$, and $Gd^{+++}(4f^7)$ obtained utilizing the above mentioned expressions and Hartree–Fock wave functions are also presented. (auth)

18732 SPIN–OTHER-ORBIT AND SPIN–ORBIT SPLITTING FACTORS FOR f^6 ELECTRON CONFIGURATIONS. Saxena, K. M. S.; Malli, Gulzari (Simon Fraser Univ., Burnaby, B. C.). Int. J. Quant. Chem., Symp.; No. 5, 619-30(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

Spin–other-orbit splitting factors (λ') and spin–orbit splitting factors (λ) for f^6 electron configuration are computed and tabulated for general usage. These are used to evaluate the Hartree–Fock values of λ' and λ for $Sm(4f^6)$, $Sm^{++}(4f^6)$, $Eu^{+++}(4f^6)$, $Gd(4f^8)$, $Gd^{++}(4f^8)$, and $Tb^{+++}(4f^8)$. (auth)

18733 SPIN–OTHER-ORBIT SPLITTING FACTORS FOR f^7 ELECTRON CONFIGURATIONS. Saxena, K. M. S.; Malli, Gulzari (Simon Fraser Univ., Burnaby, B. C.). Int. J. Quant. Chem., Symp.; No. 5, 631-42(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

Spin–other-orbit splitting factors (λ') for f^7 electron configurations are calculated and tabulated for general use. These results and Hartree–Fock wave functions are used to evaluate λ' for $Eu(4f^7)$, $Eu^{2+}(4f^7)$, and $Gd^{3+}(4f^7)$. (auth)

18734 ERROR BOUNDS FOR R^{-8} DISPERSION FORCES BETWEEN ATOMS. Starkschall, George; Gordon, Roy G. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 56: No. 5, 2102-5 (1 Mar 1972).

Error bounds for the coefficient of the R^{-8} dipole–quadrupole dispersion term describing the interaction between two He atoms were calculated by constructing oscillator-strength and transition-frequency spectra that reproduce known dipole and quadrupole oscillator-strength sums. The equations obtained are solved by means of linear programming (LP), and the LP solutions are compared with the exact solutions. The effect of uncertainties in the oscillator-strength sums is explicitly accounted for in the LP solution. (auth)

18735 STUDY OF ELECTRON CORRELATION IN THE HYDRIDE ION. Winter, Nicholas Wilhelm (Battelle Memorial Inst., Columbus, Ohio). J. Chem. Phys.; 56: No. 5, 2267-71 (1 Mar 1972).

The influence of angular correlation on the wave function and energy of the hydride ion was investigated by solving various angular limit equations through the I limit. Several one-electron properties are presented along with three-dimensional plots of the wave function. The extrapolated energy is −0.527743 au compared to the exact value of −0.527751 au. (auth)

18736 MICROWAVE–OPTICAL MAGNETIC RESONANCE INDUCED BY ELECTRONS (MOMRIE) IN $H_2G(3d^1\Sigma_g^+)$. Freund, Robert S.; Miller, Terry A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys.; 56: No. 5, 2211-9(1 Mar 1972).

The $G(3d^1\Sigma_g^+)$ state of H_2 was investigated, using a new form of molecular double resonance spectroscopy, microwave–optical magnetic resonance induced by electrons (MOMRIE). This state is excited by electron bombardment of ground-state H_2 molecules residing in a microwave cavity in a magnetic field. Because of L-uncoupling effects, the magnetic moment is of the order of one Bohr magneton so its Zeeman levels can be tuned to resonance with X-band microwave-frequency radiation by kilogauss magnetic fields. Such resonances are observed via changes in the polarization of the emitted visible radiation when the state decays. In attempting to interpret the MOMRIE spectrum, previous work on the optical energy levels of the 3d complex was reviewed, and the Zeeman effect calculated therefrom was found to be inadequate to match the present experimental precision; this is probably because of perturbations or inaccuracies in the previously reported optical spectrum. From an approximate Zeeman theory values for the lifetime, g value, and nonlinear Zeeman effect in the N = 1 level of the $G(3d^1\Sigma_g^+)$ state were obtained. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 18916 and 19347.

18737 (LBL–592) MUON DEPOLARIZATION AND THE CHEMISTRY OF FREE RADICALS. Brewer, J. H.; Crowe, K. M.; Johnson, R. F.; Schenck, A. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 9p. (CONF-710911–11; CONF-710933–3). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

From Muon physics conference; Fort Collins, Colo. (6 Sep 1971).

Polarized positive muons were stopped in solutions of bromine and iodine in benzene, and the precession of their polarization in a 200-G transverse magnetic field was observed via their asymmetric decay. The magnitude and apparent initial direction of the polarization depended strongly upon the Br_2 or I_2 concentration. The details of this behavior strongly indicate that muonium is formed and subsequently reacts with benzene to form the radical $C_6H_6Mu^{\cdot}$, which later reacts with the dissolved reagent to form a diamagnetic compound. Chemical rate constants and other relevant parameters are extracted. (auth)

18738 ANNIHILATION OF POSITRONS IN METHANE AT HIGH DENSITIES. McNutt, J. D.; Summerour, V. B. (Univ. of Texas, Arlington). Phys. Rev., B; 5: No. 5, 2019-21(1 Mar 1972).

Measurements of positron-lifetime spectra in methane gas at 23°C, previously reported at gas densities less than 1.5×10^{-2} g/cm^3, were extended to a density of 5.2×10^{-2} g/cm^3. The quenching rate of orthopositronium continues to be proportional to the gas density and corresponds to $^1Z_{eff} = 0.437 \pm 0.010$. The annihilation rates of positrons that do not form positronium deviate markedly

from the linear density dependence observed at lower densities. (auth)

18739 STRONG INTERACTION SHIFTS AND WIDTHS IN LIGHT KAONIC ATOMS. Backenstoss, G.; Bamberger, A.; Bergstroem, I.; (and others) (CERN, Geneva. Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger. Max-Planck-Institut fuer Kernphysik, Heidelberg. Research Inst. for Physics, Stockholm). Phys. Lett.; 38B: No. 3, 181-7(7 Feb 1972).

Energy shifts and line widths of x-ray transitions in kaonic atoms were measured with an accuracy of about 10%. These data are interpreted in terms of an optical potential. Whereas earlier approaches based on the free $\bar{K}-N$ scattering lengths fail to reproduce the data, a set of effective parameters consistent with all now-available experiments could be derived. (auth)

18740 DECAY OF THE COHERENT SPIN PRECESSION OF POLARIZED POSITIVE MUONS IN PARAMAGNETIC $MnCl_2$ SOLUTIONS. Schenck, A. (Univ. of Washington, Seattle); Williams, D. L.; Brewer, J. H.; Crowe, K. M.; Johnson, R. F. Chem. Phys. Lett.; 12: No. 4, 544-8(15 Jan 1972).

Slow depolarization of μ^+ in a transverse field was used to measure relaxation effects in paramagnetic $MnCl_2$ solutions. T_2^{-1} data show nonlinear dependence on ion concentration. Consistent explanation is achieved by assuming that the muon replaces a proton, forming μHO, and applying relaxation mechanisms as developed for Mn^{2+} solutions from NMR and ESR studies. T_2 temperature dependence in a 3M solution is compatible with concentration-dependent activation energy for rotational models of the $Mn^{2+}(H_2O)_6$ complex. (auth)

Collision Phenomena

Refer also to abstracts 17821, 18836, 19148, and 19487.

18741 ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS AT 180° IN CO_2. Burrow, P. D.; Sanche, L. (Yale Univ., New Haven). Phys. Rev. Lett.; 28: No. 6, 333-6(7 Feb 1972).

A technique is described for the study of electrons elastically scattered from a gas target into a small solid angle centered at 180° with respect to the direction of the incident electron beam. The method is applied to electron scattering from CO_2. Information is obtained concerning the nature of the compound state in the 4-eV region. (auth)

18742 COMPTON SCATTERING OF X RAYS FROM Ne, N_2, AND O_2: A COMPARISON OF THEORY AND EXPERIMENT. Eisenberger, P. (Bell Telephone Labs., Murray Hill, N. J.); Henneker, W. H.; Cade, P. E. J. Chem. Phys.; 56: No. 3, 1207-9(1 Feb 1972).

Experimental and theoretical Compton profiles are presented for gaseous Ne, N_2, and O_2. A comparison between experiment and theory indicates the ability of the Compton scattering technique to accurately probe many-electron systems if impulse-approximation corrections are made. The need to achieve Hartree–Fock accuracy in molecular wave functions is emphasized. (auth)

18743 MOLECULAR AUTOIONIZATION LIFETIMES AND CROSS SECTIONS FOR PENNING IONIZATION: NUMERICAL RESULTS FOR He^* $(1s2s^3S) + H$ $(1s^2S)$. Miller, W. H.; Slocomb, C. A.; Schaefer III, Henry F. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 3, 1347-58(1 Feb 1972).

The width Γ (or lifetime $\hbar/\Gamma$) for autoionization of $He^*(1s2s^3S) + H(1s^2S)$ was calculated as a function of internuclear distance, and cross sections for Penning and associative ionization ($He^* + H \rightarrow He + H^+ + e^-$, $HeH^+ + e^-$) were determined for low collision energies. Associative ionization is 22% of the total ionization cross section in the limit of zero collision energy; this fraction decreases with increasing energy, being ~18% at a collision energy corresponding to 300°K. The distribution in energy of the ionized electron is also calculated, and it is seen that measurement of this quantity should lead to a good estimate of the well depth of the He^*-H potential. Comparison of these results with those obtained by an orbiting model shows that the model (suitably scaled) is adequate in predicting the total ionization cross section, but is less accurate for the more detailed collision properties. (auth)

18744 COLLISIONAL RELAXATION PROCESSES FOR THE n = 3 STATES OF HELIUM. III. TOTAL LOSS RATES FOR NORMAL ATOM COLLISION. Wellenstein, H. F.; Robertson, W. W. (Univ. of Texas, Austin). J. Chem. Phys.; 56: No. 3, 1411-2(Feb 1972).

It is pointed out that normal collisional deactivation processes for n = 3 states of helium are excitation transfer and associative ionization and that the sum of the cross sections for these two processes should equal the total normal atom collision loss cross section. Cross sections for these two processes and their respective sums are tabulated for each of the n = 3 states of helium, and these values are compared with results of others. (A.G.W.)

18745 COMPUTATION OF ELASTIC SCATTERING PHASE SHIFTS VIA ANALYTIC CONTINUATION OF FREDHOLM DETERMINANTS CONSTRUCTED USING AN L^2 BASIS. Reinhardt, W. P.; Oxtoby, D. W.; Rescigno, T. N. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 28: No. 7, 401-3(14 Feb 1972).

It is shown that the Fredholm determinant for the Lippmann–Schwinger equation may be computed for the complex energies using only L^2 basis functions. Analytic continuation to the real axis in the $E + i\epsilon$ limit gives elastic scattering phase shifts over a continuous range of energies, showing that it is not necessary to explicitly enforce asymptotic boundary conditions for numerical scattering computations and suggesting that elastic electron–atom or –ion scattering information may be obtained using standard bound-state configuration-interaction methods. (auth)

18746 COLLISIONAL RELAXATION PROCESSES FOR THE n = 3 STATES OF HELIUM. I. EXCITATION TRANSFER BY NORMAL ATOMS AND BY ELECTRONS. Wellenstein, H. F.; Robertson, W. W. (Univ. of Texas, Austin). J. Chem. Phys.; 56: No. 3, 1072-6(1 Feb 1972).

The positive column of a glow discharge through helium served as a reactor where each of the n = 3 states of helium was selectively modulated by absorption of radiation. By monitoring the in-phase component of radiation from adjacent n = 3 states over a range of discharge currents and pressures, rate constants were determined for transfer of excitation between n = 3 states by collision with normal atoms and with electrons. (auth)

18747 COLLISIONAL RELAXATION PROCESSES FOR THE n = 3 STATES OF HELIUM. II. ASSOCIATIVE IONIZATION. Wellenstein, H. F.; Robertson, W. W. (Univ. of Texas, Austin). J. Chem. Phys.; 56: No. 3, 1077-82(1 Feb 1972).

Rate constants for the associative ionization reaction $He^* + He \rightarrow He_2^+ + e$ were measured, where He^* represents the n = 3 states of helium. By line absorption from the metastable 2^1S and 2^3S states, the n = 3 states in the positive column of a dc discharge in helium were selectively and periodically modulated. Using phase-sensitivity detection, the changes in excited-state populations were determined spectroscopically while the corresponding in-phase variations in the concentration of He_2^+ were measured with a quadrupole mass filter. The cross sections for associative ionization in units of 10^{-16} cm^2 were determined to be: $\sigma(3^3P) = 1.6 \pm 0.1$, $\sigma(3^1P) = 3.1 \pm 1$, $\sigma(3^3D) = 4.5 \pm 0.5$, and $\sigma(3^1D) = 20 \pm 4$. $\sigma(3^3S)$ and $\sigma(3^1S)$ were apparently zero. (auth)

18748 STUDIES OF CHARGE EXCHANGE IN A HIGH-PRESSURE PULSED ELECTRON IMPACT SOURCE. Sen Sharma, D. K.; Hierl, P. M.; Franklin, J. L. (Rice Univ., Houston, Tex.). J. Chem. Phys.; 56: No. 3, 1095-9(1 Feb 1972).

A high-pressure pulsed ion source was used in a time-of-flight mass spectrometer in order to study the charge-exchange reactions in $Ar-H_2$ and $Ar-D_2$ systems using the ion source in the Čermák mode of operation. As the source was used in a pulsed mode, it was possible to identify the various secondary ions arising from the charge-exchange reactions in these systems. Very good agreement was shown to exist between the experimental results and simple theoretical deductions. Calculations were made to determine the cross sections for the charge-exchange reactions between the various species from the experimental data. (auth)

18749 POPULATION AND PREDISSOCIATION OF VIBRONIC STATES OF NITRIC OXIDE. Bubert, H. (Max-Planck-Institut fuer Biophysikalische Chemie, Goettingen, Ger.). J. Chem. Phys.; 56: No. 3, 1113-16(1 Feb 1972).

In a crossed-beam experiment nitric oxide molecules are excited by electrons. From the observed emission of the γ bands ($A\ ^2\Sigma^+ \rightarrow X\ ^2\Pi$) the mean electronic transition moment $\bar{R}_e$ and the population of the vibrational levels v' = 0, 1, and 2 of the $A\ ^2\Sigma^+$ state are determined. The population numbers are compared with values calculated from kinetic equations. Relative rate constants are given corresponding to the transitions $D\ ^2\Sigma^+$, v' = j → $A\ ^2\Sigma^+$, v'' = j with j = 1 and 2. From this it can be concluded that a predissociation occurs in the $D\ ^2\Sigma^+$, v' = 2 state. (auth)

18750 CALCULATION OF TRANSITION PROBABILITIES FOR COLLINEAR ATOM–DIATOM COLLISIONS WITH NONPAIRWISE INTERACTIONS. Shipsey, Edward J. (Sandia Labs., Albuquerque, N. Mex.). J. Chem. Phys.; 56: No. 3, 1179-84(1 Feb 1972).

Vibrational transition probabilities are calculated for a model collinear atom–diatom collision. The collision is that of an O atom with an N_2 molecule. The interaction is 0.3 that of the corresponding triatomic, N_2O. The calculation is done in the close-coupling approximation which is briefly discussed. The results show many

Feshbach resonances, which influence the ground-state elastic probability, P_{11}, less and less as the number of open channels increases. (auth)

18751 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 6, NO. 12, 1971. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 59p.

This listing contains 123 references on various aspects of surface and vacuum physics. (M.O.W.)

18752 ANALYTICAL EXPRESSIONS FOR EXCITATION AND IONIZATION CROSS-SECTIONS AND RATE COEFFICIENTS OF HYDROGEN-LIKE IONS BY ELECTRON AND PROTON IMPACT. Jacobs, A. (Space Research Lab., Utrecht). J. Quant. Spectrosc. Radiative Transfer; 12: No. 2, 243-57(Feb 1972).

Excitation and ionization cross sections in the Bethe–Born approximation were computed for a model of the hydrogen-like ion consisting of seven discrete energy levels and a continuum. An interpolation formula is proposed connecting the high-energy behavior (Bethe–Born) of the cross sections and their values at threshold (Coulomb–Born I). This formula is compared with other frequently used formulae. Excitation and ionization rate coefficients in a Maxwellian plasma were computed. (auth)

18753 ROTATIONAL AND VIBRATIONAL EXCITATION OF H_2 BY SLOW ELECTRON IMPACT. Linder, F.; Schmidt, H. (Univ. Trier, Kaiserslautern, Ger.). Z. Naturforsch.; 26a: No. 10, 1603-17(Oct 1971).

In a beam experiment the processes of elastic scattering, pure rotational excitation and deexcitation, pure vibrational excitation, and simultaneous rotational–vibrational excitation were investigated for e–H_2 scattering in the energy range from 0.3 eV to about 15 eV. Differential and integral cross sections were determined in arbitrary units and calibrated on an absolute scale by normalization to absolute total cross sections. The results are discussed in terms of superposition of direct scattering, shape resonance and Feshbach resonance scattering and are compared with recent theoretical investigations. The cross sections for rotational and vibrational excitation, which are generally small for direct scattering, are greatly enhanced by a broad shape resonance near 3 eV and by Feshbach resonances around 12 eV. Characteristic differences in the excitation mechanisms are discussed. (auth)

18754 EXPERIMENTAL STUDY OF LOW-ENERGY e–O_2 COLLISION PROCESSES. Linder, F.; Schmidt, H. (Univ. Trier, Kaiserslautern, Ger.). Z. Naturforsch.; 26a: No. 10, 1617-25(Oct 1971).

Elastic scattering, vibrational excitation to v = 1, 2, 3, 4 of the electronic ground state, and electronic excitation to the states $a^1\Delta g$ and $b^1\Sigma_g^+$ of O_2 were measured in a crossed-beam apparatus for collision energies from nearly 0 eV to 4 eV. Differential and integral cross sections were determined and calibrated on an absolute scale. From 15 vibrational levels of O_2^-, which could be observed as resonances in the cross sections, the spectroscopic constants for the vibrational structure of O_2^- were derived: ω_e = 135 meV and $\omega_e x_e$ = 1 meV. The cross sections for vibrational excitation have the order of 10^{-18} cm^2 · eV for the larger resonance peaks. Detailed cross sections are tabulated. The half width of the resonance can be estimated to $\Gamma \approx 0.5$ meV, which corresponds to a lifetime of 10^{-12} s for the O_2^- states. The angular dependence of pure resonance scattering is rather flat and not in accordance with the simplest theoretical model. An analysis of the angular dependence and of the rotational structure of the resonance in a somewhat extended model was performed. No electronically excited O_2^- states could be detected in the energy range up to 3 eV. (auth)

18755 ANGULAR SPREAD OF HYDROGEN ATOMS FORMED BY ELECTRON CAPTURE AND DISSOCIATION OF H^+, H_2^+, AND H_3^+ IN H_2, H_2O, AND C_8F_{16} AT ENERGIES OF 2.5 TO 15 keV. Payne, M. F.; Riviere, A. C. (Culham Lab., Abingdon, Eng.). J. Phys., D (London); 5: No. 1, 69-78(Jan 1972).

Data are presented on the angular spread of neutral atoms formed by electron capture and dissociation of H^+, H_2^+, and H_3^+ in H_2, H_2O, and C_8F_{16} targets. Measurements were made at energies of 2.5 to 15 keV and for a range of target densities. The results are presented as the fraction transmitted through an aperture of a given half-angle. It is deduced that the angular spread of atoms from H_2^+ and H_3^+ molecular ion beams was predominantly due to the internal excitation energy of the molecular ions and not to simple scattering, even at the lower energies. The angular spread of atoms formed by electron capture by H^+ in H_2O varied with energy as $E^{-0.6}$; this is compared with the cross section for single scattering of H^+ on oxygen atoms obtained from the classical theory of Firsov, which varies as E^{-1}. (auth)

18756 INTERMOLECULAR POTENTIALS FROM CROSSED-BEAM DIFFERENTIAL ELASTIC SCATTERING MEASUREMENTS. IV. Ar + Ar. Parson, J. M.; Siska, P. E.; Lee, Y. T. (Univ. of Chicago). J. Chem. Phys.; 56: No. 4, 1511-16(15 Feb 1972).

High-resolution low-energy elastic differential cross sections were measured for Ar–Ar over a wide angular range. Rainbow structure and symmetry oscillations at wide angles were resolved. These results are used to evaluate 16 different Ar–Ar potentials proposed previously and also to construct a new potential. Vibrational energy levels and the second virial coefficient calculated for the new potential are compared with experimental results. (auth)

18757 CLASSICAL EVALUATION OF AVERAGED COLLISION RATES: EHRENFEST THEOREM IN NEAR CLASSICAL COLLISION THEORY. Levine, R. D. (Ohio State Univ., Columbus). J. Chem. Phys.; 56: No. 4, 1633-7(15 Feb 1972).

The change in an observable due to collisions is written, using near classical collision theory, as a simple average over the initial internal state. For most observables of physical interest this average assumes the usual form of a classical phase average. The most valid means of characterizing the distribution of final states is in terms of its moments. (auth)

18758 EXCITATION OF POTASSIUM IONS BY COLLISIONS WITH ARGON ATOMS. Pop, S. S.; Zapesochnyi, I. P. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 1, 3-6(Jul 1971).
Translated from Opt. Spektrosk.; 31: No. 1, 8-13(Jul 1971).

The excitation cross sections for the lines 3898, 4135, 4149, 4186, 4263, 4305, 4309, 4388, 4829, and 5006 Å of K II, 4545 Å and 4880 Å of Ar II, and K II (λ = 4608 Å) + Ar II (λ = 4610 Å) by collisions of K^+ ions with Ar atoms in the ion energy range 0.3 to 30 keV were investigated. The maximum values of the excitation cross sections of the investigated K II lines are in the limits (1.0 to 5.8) × 10^{-18} cm^2. On the graphs of the excitation functions of the Ar II lines, one or two clearly expressed maxima are observed. The maximum values of the excitation cross sections of the Ar II lines are ~ 10^{-19} cm^2. Total excitation cross sections of all lines of the K^+ ions in the visible spectral region for the K^+ + He, K^+ + Ne, and K^+ + Ar pairs were compared with theoretical cross sections of the Landau–Zener two-term model. (auth)

18759 ELECTRON SCATTERING OFF ATOMS FOR EXCITATIONS TO VALENCE AND RYDBERG STATES. Miller, Kenneth J. (Rensselaer Polytechnic Inst., Troy, N. Y.). Int. J. Quant. Chem., Symp.; No. 5, 71-81(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

Differential cross sections for the atomic transitions 2p(ns) and 2p(np) are studied within the first Born approximation by using a one-electron model based on hydrogen-like orbitals with appropriate effective nuclear charges. For single electron excitations, the related dimensionless quantity, the generalized oscillator strength, can be scaled to yield f(κ), which depends upon the ratio of effective nuclear charges and reduced momentum transfer κ. Calculations of f(κ) versus κ show that Rydberg series exhibit in f(κ) extrema that are nearly the same for all members of the series, whereas excitations to different series exhibit a different number and positioning of the extrema. These trends suggest that patterns in generalized oscillator strengths can be used as an experimental tool to probe various types of transitions and to unravel Rydberg series. Comparison of theoretical values with available experimental results indicates close agreement. (auth)

18760 EXPERIMENTAL EVIDENCE FOR A SPECTATOR MECHANISM IN THE DISSOCIATION OF H_2 BY SINGLE COLLISIONS WITH Li^+. Schoettler, J.; Toennies, J. P. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Ger. Univ., Bonn). Chem. Phys. Lett.; 12: No. 4, 615-19(15 Jan 1972).

Measured time-of-flight distributions of scattered Li^+ ions from a "stationary" H_2 target provide evidence for dissociation by a spectator mechanism at laboratory energies greater than 120 eV. (auth)

18761 COLLISIONS BETWEEN FAST HYDROGEN ATOMS AND ALKALI AND INERT-GAS TARGETS. Vinogradov, A. V.; Shevel'ko, V. P. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1116-18(Jan 1972).
Translated from Zh. Tekh. Fiz.; 41: No. 7, 1419-22(Jul 1971).

The excitation of the 1s–2p transition in fast hydrogen atoms that strike alkali-metal and inert-gas targets is considered. Particular attention is given to collisions that result in excitation of target atoms. The reaction H(1s) + A(ns) → H(2p) + A(np), where A is the alkali metal, is analyzed. It is shown that the excitation of the core electrons must be taken into account. (auth)

18762 SEMICLASSICAL CALCULATION OF THE VIBRATIONAL TRANSITION PROBABILITIES OF DIATOMIC MOLECULES IN COLLISION. THE EFFECT OF VIBRATIONAL ANHARMONICITY. Yonezawa, Yoshiro; Funeo, Takayuki (Osaka Univ.). Bull. Chem. Soc. Jap.; 44: No. 11, 2976-80(Nov 1971).

The multistate semiclassical method proposed by Sharp and Rapp for calculating the vibrational transition probabilities of harmonic oscillators in collision was extended to Morse oscillators. Model calculations were carried out for the excitation of a vibrational-ground-state hydrogen molecule colliding with a helium atom at varying relative velocity. It is shown that the Morse oscillator model gives greater transition probabilities than the corresponding harmonic oscillator model. (auth)

18763 CALCULATIONS ON THE e–H CROSS SECTION BY THE CORRELATION METHOD USING A MODIFIED POTENTIAL. Feiden, M. M.; Braun, J.C.; Richard, M. (Laboratoire de Physique des Milieux Ionises, Nancy). Phys. Lett.; 38A: No. 5, 375-6(28 Feb 1972).

A modification of the e–H attractive potential is proposed; and a study of its effect on the 1s → 2s, 1s → 2p and ionization cross-section calculations is made. Numerical results are compared with those previously obtained. (auth)

18764 WATER EXCITATION BY ELECTRON IMPACT (BETWEEN 3 AND 6 eV). Azria, Roger; Piquet-Fayard, Florence (Univ. Paris, Orsay, France). Compt. Rend., Ser. B; 273: No. 22, 944-7(29 Nov 1971). (In French).

The excitation of water vapor by electron impact was investigated in the eV energy range (3 to 6 eV) where the presence of a $^3B_1$ triplet had been previously suggested. (France)

18765 EXACT QUANTUM-MECHANICAL TRANSITION PROBABILITIES FOR THE LANDAU–TELLER INTERACTION. Roberts, R. E. (Indiana Univ., Bloomington); Diestler, D. J. J. Chem. Phys.; 56: No. 5, 2482-4(1 Mar 1972).

Calculations of exact quantum-mechanical transition probabilities for the Landau–Teller interaction, $V = \exp(-\alpha x)(1 + \alpha y)$. Results for the case $v = 0 \rightarrow 1$ are tabulated and compared with results from simple perturbation theory. Some results are also shown for multiple excitations. (A.G.W.)

18766 SEMICLASSICAL TRANSITION PROBABILITIES FOR COLLINEAR DIATOM–DIATOM COLLISIONS. Morse, R. I. (Clark Univ., Worcester, Mass.). J. Chem. Phys.; 56: No. 5, 2329-32(1 Mar 1972).

The semiclassical model of Heidrich, Wilson, and Rapp is extended to include translation–vibration transition probabilities for the collinear collision of diatomic molecules. The results for H_2–H_2 collisions are compared with quantum mechanical results and found to be in good agreement. (auth)

18767 POST-THRESHOLD ENERGY DEPENDENCE OF THE CROSS SECTION FOR ENDOERGIC PROCESSES: VIBRATIONAL EXCITATION AND REACTIVE SCATTERING. Levine, R. D.; Bernstein, R. B. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 56: No. 5, 2281-7(1 Mar 1972).

The essential features of the translational energy dependence or excitation function $\sigma(E_{tr})$ for two types of endoergic collisional processes are deduced on the basis of information on the inverse, exoergic processes. Microreversibility is conveniently exploited via the symmetric yield function, Y(E), which is uniquely determined at a given total energy, E. In the case of the vibrational excitation of diatomic molecules by atomic or molecular impact (T → V), use is made of the abundant data on the temperature dependence of the V → T relaxation time τ. The usual semi-empirical two-parameter representation of the relaxation process is transformed to yield an explicit functionality for the translational energy dependence of the inelastic excitation cross section $\sigma_{0\rightarrow1}(E_{tr})$, in the adiabatic region. For diatomics whose relaxation is slow (e.g., slow enough to be studied in a shock tube) the vibrational excitation cross section $\sigma_{0\rightarrow1}$ is exponentially small in the post-threshold region. These systems would be unsuitable for study by the crossed-beam technique; the latter thus complements rather than replaces the more traditional relaxation methods. Also considered are endoergic chemical reactions whose inverse processes involve negligible activation barriers (e.g., ion–molecule reactions, reactive atom–molecule reactions, etc). In all cases the dominant post-threshold energy dependence of the reactive cross section $\sigma_R(E_{tr})$ for the endoergic process is fixed via the microreversibility constraint, so experimental data in this region do not provide as much information as is available from studies of the exoergic process. The deviation from a simple Arrhenius cross section functionality is determined by the long-range final product interaction. (auth)

18768 VACUUM-ULTRAVIOLET EXCITATION CROSS SECTIONS BY ELECTRON IMPACT ON NO. Mentall, J. E. (Goddard Space Flight Center, Greenbelt, Md.); Morgan, H. D. J. Chem. Phys.; 56: No. 5, 2271-7(1 Mar 1972).

Absolute excitation functions were measured for the NO^+ A $^1\Pi$–X $^1\Sigma^+$ molecular band system, the nitrogen 1200-, 1243-, and 1493-Å multiplets, and oxygen 1304-Å multiplet. Excitation was by electron impact on NO threshold to ~250 eV. At 100 eV the excitation cross section for the NO^+ A–X system is 9.7×10^{-18} cm^2 while the cross sections for the nitrogen and oxygen multiplets are: N 1200 Å, 4.8×10^{-18} cm^2; N 1243 Å, 0.89×10^{-18} cm^2; N 1493 Å, 1.5×10^{-18} cm^2; and O 1304 Å, 1.1×10^{-18} cm^2. From the vibrational intensity distribution of the A–X system, the variation of electronic transition moment with r centroid was determined and this result used to calculate an array of vibrational transition probabilities. In addition, cross sections were measured at 100 eV only for the N 1135-, N 1745-, O 1152- and O 1218-Å multiplets. Cross sections for these multiplets are: N 1135 Å, 1.6×10^{-18} cm^2; N 1745 Å, 0.87×10^{-18} cm^2; O 1152 Å, 0.85×10^{-18} cm^2; and O 1218 Å, 0.39×10^{-18} cm^2. (auth)

18769 LOW-ENERGY REPULSIVE INTERACTION POTENTIAL FOR HELIUM. Cantini, P.; Dondi, M. G.; Scoles, G.; Torello, F. (Univ., Genoa). J. Chem. Phys.; 56: No. 5, 1946-56 (1 Mar 1972).

New measurements of the integral elastic cross section for a ^{4}He velocity-selected supersonic molecular beam scattered by a ^{4}He gas target at 2°K are reported. The structure in the velocity-dependent cross section arising from the quantum statistics is well resolved and gives precise information about the weakly repulsive potential at values corresponding to the collision energies (5 to 30 MeV). It is shown that the measured property is insensitive to both the attractive and strongly repulsive parts of the potential. The error in the determination of the potential due to the uncertainty of the velocity-selector calibration is discussed. A comparison of the present data with predictions from recently proposed helium potentials is made, and information on the weakly repulsive interaction obtained from this and other experimental data is summarized. (auth)

18770 MOLECULAR DYNAMICS: THE DISSOCIATION OF H_2 BY He. Brown, Nancy Jeanne; Munn, Robert J. (Univ. of Maryland, College Park). J. Chem. Phys.; 56: No. 5, 1983-7(1 Mar 1972).

The dissociation of molecular hydrogen by helium was studied at 5500°K using the quasi-classical approximation. The temperature-dependent reaction cross sections were very dependent on the initial quantum states of the molecule. A rate constant was estimated for the dissociation reaction, and agreement between theory and experiment was satisfactory. (auth)

18771 LYMAN-ALPHA EMISSION CROSS SECTIONS FOR COLLISIONS OF 1- TO 25-keV H^+ AND H WITH CO, CO_2, CH_4, AND NH_3. Birely, J. H.; McNeal, R. J. (Aerospace Corp., El Segundo, Calif.). J. Chem. Phys.; 56: No. 5, 2189-94(1 Mar 1972).

Cross sections are reported for emission of Lyman-α radiation n collisions of H^+ and H with CO and CO_2 in the 1- to 25-keV energy range and with CH_4 and NH_3 in the range 5 to 25 keV. In the experiments with CH_4 and NH_3 the Doppler-shifted Lyman-α, emitted by H(2p) formed in electron capture by fast incident protons or collisional excitation of fast incoming hydrogen atoms, and the virtually unshifted Lyman-α, emitted by the far slower H(2p) produced in dissociative excitation, were separated. An electric field was applied within the collision chamber, and the increase in Lyman-α intensity was used to derive cross sections for formation of H(2s). For CO and CO_2 targets, H projectiles are more efficient than H^+ in formation of H(2p), while at energies above 10 keV, H^+ is more efficient than H in formation of H(2s). For both projectiles, the probability of formation of H(2p) is greater than or equal to the probability of forming H(2s). For CH_4 and NH_3 targets the projectile excitation cross sections are generally similar to those for CO and CO_2, and the total projectile excitation cross section for formation of H (n = 2) exceeds that for dissociative excitation in either H^+ or H impact. For both projectiles formation of H(2p) in dissociative excitation is at least an order of magnitude more probable than formation of H(2s). Protons are found to be more efficient than hydrogen atoms in production of Lyman-α via dissociative excitation. Relationships are presented between the projectile excitation cross section and the cross section for electron capture in H^+ impact or stripping in H impact, which are relatively independent of the identity of the target molecule. (auth)

18772 ELECTRON-IMPACT CROSS SECTIONS AND ENERGY DEPOSITION MOLECULAR HYDROGEN. Miles, W. T.;

Thompson, R.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Appl. Phys.; 43: No. 2, 678-86(Feb 1972).

Using the concept of the generalized oscillator strength in the Born–Bethe approximation together with semiphenomenological techniques previously developed, a diverse body of experimental and theoretical data on molecular hydrogen is assembled into sets of analytical electron-impact cross sections. Discrete, vibrational, and dissociative excitations, together with direct and dissociative ionization are included in the analysis. Once the important cross sections are known, it is then possible to trace the energy degradation of an incident electron upon molecular hydrogen. Results are given for the electron loss function, efficiencies, and eV/ion pair together with comparison to available experimental data. (auth)

18773 SINGLE-CHARGE TRANSFER BETWEEN He^{++} AND He, Ne, AND Ar: OBSERVED SELECTION RULE FOR EXIT CHANNELS. Siegel, M. W.; Chen, Y. H.; Boring, J. W. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 28: No. 8, 465-8(21 Feb 1972).

Single-charge-transfer channels in the systems He^{2+}–He, –Ne, –Ar are observed for He^{2+} energies 0.2 to 1.0 keV and $He^{+(*)}$ exit angles 0 to 15°. ($He^{+(*)}$ denotes either the ground state or an excited state.) The ground-state channels have cross sections below the present 10^{-20}-cm^2 detection limit. Outgoing channels are found to be favored when their separated ions can originate with the same molecular symmetry as the incoming channel. (auth)

18774 CALCULATION OF ATOMIC COLLISION PROCESSES. Smith, Kenneth. New York; John Wiley and Sons, Inc. (1971). 226p. $13.95.

The application of digital computers to computation of cross sections for atomic and molecular collision processes is discussed. The first part deals with single-channel problems and includes chapters on potential scattering, resonance phenomena, the static-field approximation, second-order ordinary differential equations, and photon–atom reactions. The second part deals with many-channel problems and includes chapters on the eigenfunction expansion method, Racah algebra, cross section formulas, numerical methods for coupled differential equations, and the close-coupling approximation. (97 references) (A.G.W.)

Atomic Theory

Refer also to abstracts 18723 and 19695.

18775 (NYO–1447-71) DEVELOPMENTS IN ATOMIC SHELL THEORY. Judd, B. R. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Jul 1971. Contract AT(30-1)-1447. 22p. Dep. NTIS.

The present status of atomic shell theory is described with particular reference to the configurations $4f^N$. A discussion is given of the usefulness in spectroscopic term analysis of effective operators, including three-electron scalars. The value of group theory in simplifying the analysis is emphasized, as well as some of the surprises and puzzles that appear in the mathematics. The new directions in research that these features suggest are outlined, particularly the possibility of introducing new groups. (25 references) (auth)

18776 ELECTRON g^3 CONFIGURATIONS IN L–S COUPLING. Patera, J. (Univ. of Montreal). J. Chem. Phys.; 56: No. 3, 1400-6(1 Feb 1972).

Total orbital momentum and total spin are good quantum numbers for a complete basis that is constructed as explicit linear combinations of orthonormal vectors $(m_1m_2m_3)$, where integers $|m_i| \leq 4$. Matrix elements of generators of the orbital momentum group are found explicitly in the basis $(m_1m_2m_3)$ and a one-to-one correspondence between $(m_1m_2m_3)$ and Gel'fand–Tseitlin patterns of SU(9) is shown. The multiplicity problem is solved systematically by simplicity conventions similar to those introduced by Racah for the cases where his classification scheme for higher f^n configurations failed. Every angular momentum multiplet constructed belongs to one irreducible representation of O(9) only. (auth)

18777 PSEUDOPOTENTIAL THEORY OF ATOMS AND MOLECULES. II. HYLLERAAS-TYPE CORRELATED PAIR FUNCTIONS FOR ATOMS WITH TWO VALENCE ELECTRONS. Szasz, Levente (Fordham Univ., New York); McGinn, George. J. Chem. Phys.; 56: No. 3, 1019-21(1 Feb 1972).

The method for the calculation of correlated pair functions developed in the first part of this series is applied to the calculation of Hylleraas-type functions for the valence electron pair of the atoms: Li^-, Be, B^+, C^{2+}, Na^-, Mg, Al^+, Si^{2+}, K^-, Ca, Rb^-, Cu^-, Zn, and Ag^-. Six-parameter expansions are computed for all these atoms and 15- and 20-parameter expansions are computed for Li^- and Be. From these results the first ionization potentials are computed and are found to be in good agreement with previous ab initio calculations and with the empirical values. (auth)

18778 K SHELL ELECTRON WAVEFUNCTIONS IN COMPLEX ATOMS. Greenland, P. T.; Irvine, J. M. (Univ. of Manchester, Eng.). J. Phys., A (London); 5: No. 1, L10-12(Jan 1972).

A simple procedure for obtaining 1s-electron wave functions in complex atoms is presented, which takes into account many-body, relativistic, and finite-nuclear-size effects. (auth)

18779 CONVERGENCE OF A PRODUCT REPRESENTATION OF THE EXPONENTIAL HAMILTONIAN OPERATOR. AN EXAMPLE FROM STATISTICAL THEORY. Handler, George S.; Wang, Pearl S. C. (Univ. of Georgia, Athens). J. Chem. Phys.; 56: No. 4, 1546-8(15 Feb 1972).

Using an iterated product representation of an exponential Hamiltonian, the density matrix for the potential $V(x) = ax$, $a > 0$, is derived in nth-order approximation. The density matrix so found is shown to converge to the exact quantum mechanical result in the limit of $n \to \infty$. (auth)

18780 DISTINGUISHABLE-ELECTRON METHOD FOR ELECTRONIC STRUCTURE CALCULATIONS. IV. POLARIZABILITY OF THREE- AND FOUR-ELECTRON ATOMS. Scott, William R.; Kirtman, Bernard (Univ. of California, Santa Barbara). J. Chem. Phys.; 56: No. 4, 1685-91(15 Feb 1972).

The distinguishable-electron perturbation method is applied to the polarizability of three- and four-electron atoms, with results comparable to much more complicated coupled Hartree–Fock calculations. For the initial approximation a product of Slater-type orbitals is used with exponents optimized via the Rayleigh–Ritz principle. Using accessible correlation expressions the polarizability can be computed to first order in correlation without resorting to correlated wave functions. The polarization functions required for this calculation are found exactly as solutions of one-electron perturbation equations. Adjustable parameters are introduced into these equations, which do not affect the energy but are optimized with respect to the polarizability property. (auth)

18781 NEW TECHNIQUES FOR COMPUTATION OF MULTICONFIGURATION SELF-CONSISTENT-FIELD (MCSCF) WAVE FUNCTIONS. Das, G.; Wahl, Arnold C. (Argonne National Lab., Ill.). J. Chem. Phys.; 56: No. 4, 1769-75(15 Feb 1972).

New techniques are described for obtaining MCSCF wave functions and energies via the expansion method. These include (i) a simple but generalized algorithm for obtaining symmetrized configurations and the corresponding vector-coupling coefficients for diagonal and off-diagonal matrix elements referred to the symmetry species of a diatomic molecule; (ii) a new iterative scheme, which leads to a fast convergence of the MCSCF process provided the starting conditions are properly chosen, and (iii) a method to ensure such proper starting conditions in regard to the form of the initial orbitals. (auth)

18782 CALCULATION OF CORRELATION ENERGY FOR A MANY-ELECTRON ATOM IN THE TWO-BODY APPROXIMATION. Klimchitskaya, G. L.; Labzovskii, L. N. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 1, 1-3(Jul 1971).

Translated from Opt. Spektrosk.; 31: No. 1, 3-7(Jul 1971).

Brenig's method was used to calculate the correlation energy of a many-electron atom. The equations describing separate groups of electrons were obtained. The correlation energy for the beryllium atom was calculated in a two-electron approximation considering all pairs of electrons. (auth)

18783 ATOMIC, MOLECULAR, AND SOLID-STATE THEORY AND QUANTUM BIOLOGY. Proceedings of the International Symposium, Sanibel Island, Florida, January 19–24, 1970. Loewdin, Per-Olov (ed.). Int. J. Quant. Chem., Symp.; No. 4, 1-484 (1971). (CONF-700116).

Separate abstracts were prepared for nine of the fifty papers presented. The remaining papers deal with molecular and solid-state theory. (A.G.W.)

For abstracts of individual papers see: 18724, 18725, 18784–18788, 19695, and 19696.

18784 STATISTICAL EXCHANGE AND THE TOTAL ENERGY OF A CRYSTAL. Slater, John C. (Univ. of Florida, Gainesville); Wood, John H. Int. J. Quant. Chem., Symp.; No. 4, 3-34(1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

The statistical exchange method is derived directly in terms of a variation of the total energy expressed in terms of the statistical exchange energy. The formulation holds for the so-called

Xα and Xαβ exchange methods. It is pointed out that though the orbitals determined by these methods agree well with Hartree–Fock orbitals in cases where the comparison can be made, the eigenvalues are different, because they represent different quantities: in the Hartree–Fock method the energy differences between the energies of the ground state and the ion lacking an electron, in the statistical method the partial derivative of the total energy with respect to the occupation number. The total energy as derived by the statistical method is discussed, as a possible substitute for the exact total energy. It is shown that the parameters α and β can be chosen so that the statistical total energy agrees exactly with the Hartree–Fock total energy, and this is recommended as the best method for choosing these parameters. It is shown that the exchange potential encountered in the Xαβ method is much further from the Hartree–Fock exchange potential than that found in the Xα method, so that the latter is to be preferred. In order to test the use of the statistical expression for total energy, the statistical total energy is studied as a function of occupation numbers, and a power series expansion of this total energy is discussed. In terms of this expansion, it is simple to discuss the difference between the eigenvalues of the Hartree–Fock and of the statistical methods. It is pointed out that when one uses an energy-band approach to a problem, one must shift electrons from one energy band to another in the iteration required to achieve self-consistency, and with the Xα method this means filling the lowest energy bands up to the Fermi energy. On the basis of such energy shifts, a qualitative discussion is given of the disappearance of magnetic moments of such atoms as vanadium, when the atoms are combined into a metallic crystal. A discussion is given of the relation between eigenvalues of of the statistical or of the Hartree–Fock method in studying the optical absorption by an insulating crystal. From a historical sketch of the development of the theory of the exciton, it is seen that absorption by such an insulating crystal is much more like absorption by an isolated atom than like the transitions between extended or Bloch functions that one meets with a metal. Consequently, though the eigenvalues of the statistical method are a reliable guide in transitions met in a metallic crystal, the absorption by an insulator should be handled differently, more like an atom, resulting in wider energy gaps than would be found by direct use of the statistical eigenvalues. (62 references) (auth)

18785 TIME-DEPENDENT HARTREE–FOCK THEORY FOR ATOMS. Jamieson, M. J. (Harvard Coll. Observatory, Cambridge, Mass.). Int. J. Quant. Chem., Symp.; No. 4, 103-15(1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

The coupled and uncoupled versions of time-dependent Hartree–Fock theory are presented. The theory provides a way of calculating the linear response of an atomic system to an external time-dependent perturbation, and thence the Green's function. It is shown that the coupled version is equivalent to the random phase approximation and that is contains correlation to at least first order, whereas the uncoupled version contains no correlation. The effect of the correlation included in the coupled version on the dipole spectrum of two-electron systems is studied. This study is based on numerical solution of the equations for the dipole response of helium and lithium II. The coupled and uncoupled dipole spectra of helium and parts of these spectra of lithium II are given. Phase shifts for electron–helium-ion scattering are also given. Calculations for helium for long-range forces, average excitation energies involved in the theory of range and straggling of fast charged particles and the Lamb shift, and the two-photon decay spectrum and radiative lifetimes for the decay $(1s2s)^1S \rightarrow (1s^2)^1S$ are described. It is concluded that, for two-electron systems, the correlation included in the coupled theory displaces rather too much dipole oscillator strength into the continuum (while maintaining the Thomas–Kuhn sum rule) and overestimates exchange in the energy levels and low-energy phase shifts and that the coupled dipole spectrum is more accurate than the uncoupled one. (29 references) (auth)

18786 ELECTRONIC PAIR CORRELATION IN ATOMS AND MOLECULES. Nesbet, R. K. (IBM Research Lab., San Jose, Calif.). Int. J. Quant. Chem., Symp.; No. 4, 117-25(1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

Work on electronic structure of atoms not covered in a review by E. U. Condon (Rev. Mod. Phys., 40: 872(1968)) is surveyed. Subjects discussed include perturbation theory of correlation corrections to Hartree–Fock theory, semi-empirical theory of correlation energy, and quantitative calculation of correlation energy. (46 references) (A.G.W.)

18787 GENERALIZED POLARIZABILITIES AND ENERGY EXPRESSIONS. Lindner, P.; Goscinski, O. (Uppsala Univ.). Int. J. Quant. Chem., Symp.; No. 4, 251-55(1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

That part of the total potential energy of a many-electron system expressible in terms of a generalized polarizability function is identified with the "nonclassical" part of the total energy, of crucial importance since it is proportional to the volume. A configuration-space derivation of a pair-function formula is presented. (auth)

18788 DENSITY-MATRIX APPROACH TO MULTICONFIGURATION CALCULATIONS. Harriman, John E. (Univ. of Wisconsin, Madison). Int. J. Quant. Chem., Symp.; No. 4, 363-70 (1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

Density-matrix components are determined for a wave function of multiconfiguration type. The array containing information required to obtain the two-electron charge density matrix can also be used to construct the N-electron (spin-free) Hamiltonian configuration-interaction matrix from the two-electron reduced Hamiltonian matrix. This array can be obtained in several ways and suggests a useful conceptual organization. (auth)

18789 ATOMIC, MOLECULAR, AND SOLID-STATE THEORY AND QUANTUM BIOLOGY. Proceedings of the International Symposium, Sanibel Island, Florida, January 18–23, 1971. Loewdin, Per-Olov (ed.). Int. J. Quant. Chem., Symp.; No. 5, 1-792 (1971). (CONF-710117).

Separate abstracts were prepared for sixteen of the eighty-six papers presented. The remaining papers deal with molecular and solid-state theory. (A.G.W.)

For abstracts of individual papers see: 17483, 18726–18733, 18759, 18790–18793, 19679, and 19692.

18790 EFFECT OF REMOVAL OF EQUIVALENCE RESTRICTIONS ON THE ELECTRONIC ENERGIES OF ATOMS. Sasaki, Fukashi; Horino, Yasuyo; Ohno, Kimio (Hokkaido Univ., Sapporo). Int. J. Quant. Chem., Symp.; No. 5, 21-33(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

Equivalence restrictions usually imposed on the Hartree–Fock approximation are removed by letting one of the 2p radial functions be different from the others. Two energy minima are found, both with a single Slater-type atomic-orbital basis and with a more extended basis. One minimum corresponds to the one-diffuse-electron model and the other to the one-tight-electron model. Although two wave functions based on these two models look different, the natural orbital analysis shows they are close to each other as a many-electron wave function. The calculation is further extended by using N radial functions for an N-electron atom. The results with the single Slater-type atomic-orbital basis are presented and are discussed. (auth)

18791 CALCULATION OF EXPECTATION VALUES CORRECT TO SECOND ORDER APPLIED TO THE GROUND STATE OF THE HELIUM ISOELECTRONIC SEQUENCE. Sahni, V.; Krieger, J. B. (Polytechnic Inst. of Brooklyn). Int. J. Quant. Chem., Symp.; No. 5, 47-58(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

A method is discussed for the determination of single-particle atomic expectation values, $\langle W \rangle$, accurate to $0(\delta^2)$ if an approximate wave function, ψ_{0T}, correct to $0(\delta)$ is employed. The technique involves writing the expectation values as a functional of ψ_{0T}, the Hamiltonian, and a subsidiary function that is the solution of a differential equation derived from certain self-consistency considerations involving both W and ψ_{0T}. Analytic calculations for $\langle r^n \rangle$, n = 2, 1, −1, −2, and the electron density at the origin $\rho(0)$ were performed for the ground state of the helium isoelectronic sequence using energy-optimized sample products of hydrogenic states as the approximation wave function. For $1 \leq Z \leq 8$, these results have an accuracy equivalent to a Hartree–Fock calculation when compared to both the results of Pekeris and a 204-term variational perturbation treatment. The least accurate of these results are for $\langle r^2 \rangle$, which for He and Li^+ are in error by 1% and 0.3%, respectively, and in all cases this error is further diminished with each increase in the atomic number. (auth)

18792 TREATMENT OF EXCHANGE IN ATOMIC, MOLECULAR, AND SOLID-STATE THEORY. Slater, J. C. (Univ. of Florida, Gainesville). Int. J. Quant. Chem., Symp.; No. 5, 403-9 (1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

The current state of the theory of the statistical exchange approximation for the self-consistent field in atoms, molecules, and solids is presented. The essential features of the Fermi statistics are reviewed. A formula for the total energy of the system is set up in terms of the spin orbitals of the one-particle states and of the occupation numbers. It is shown that the requirements of self-consistency are met and that the assumption that the Fermi statistics hold in this method is justified. Some applications of the technique are considered briefly. (A.G.W.)

18793 STATISTICAL EXCHANGE APPROXIMATION FOR LOCALIZED ELECTRONS. Lindgren, Ingvar (Yale Univ., New Haven. Chalmers Univ. of Tech., Gotteborg). Int. J. Quant. Chem., Symp.; No. 5, 411-20(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

An approximate expression for the interelectronic exchange is derived from the free-electron-gas model in a way similar to the ordinary Slater $\rho^{1/3}$ approximation. This is combined with the exact expression for the self-interaction (same as in the Hartree potential) to an approximation of the full Hartree–Fock (HF) exchange. This approximation—called the Hartree–Slater approximation—does not contain any adjustable parameters. A (nonlocal) potential, to be used in the self-consistent-field procedure, is obtained from the energy expression by use of the variational principle. This scheme has been tested in atomic calculations—nonrelativistic as well as relativistic—and found to reproduce the HF exchange better than any available local exchange potential. The new exchange approximation is therefore believed to be of general validity and applicable not only to free atoms. Since only exchange is considered in the present work, the applications are limited to cases where screening and other correlation effects are not too important. Possible applications are heavy atoms (as a substitute for relativistic HF), molecules, and localized electrons in solids, e.g., d and f electrons in transition elements. (auth)

18794 CALCULATION OF ENERGY LEVELS FOR ATOMS IN CONFIGURATIONS $1s^22s^2p^q$nl. Saraph, Hannelore E.; Seaton, M. J. (University Coll., London). Phil. Trans. Roy. Soc. London Ser. A; 271: No. 1211, 1-39(17 Dec 1971).

Reactance matrices for electron collisions with ions in configurations $1s^22s^2p^q$ (q = 1 to 5), calculated by Saraph, Seaton & Shemming (1969), were fitted to analytic functions of the energy and extrapolated to energies that give bound states with configurations $1s^22s^2p^q(S_1L_1)$ nl SL. The positions of the bound states are calculated using methods of many-channel quantum defect theory. Allowance can be made for the fine-structure energy of the ion core by using a representation $(S_1L_1J_1)$nlj J or a pair-coupling representation $(S_1L_1J_1)$nlK, J. The calculated level positions are compared with positions determined experimentally. The most detailed results are for the np levels, but some results are given for ns and nd levels. Some semi-empirical adjustments are made in the calculated matrices, so as to obtain improved agreement between observed and calculated levels. In many cases the most serious source of error in the calculations is the neglect of interactions between configurations $2s^22p^q$nl and $2s2p^{q+1}$n'l'. For the more highly ionized systems these interactions give rise to perturbed series. A discussion of results for valence-electron states in the neutral atoms C I, N I, O I, F I, and Ne I is followed by a discussion of the various isoelectronic sequences. The results make it possible to assess the accuracy of the calculated reactance matrices and to make identifications. In most cases, but not all cases, the assignments obtained for parentage and for pair-coupling quantum numbers agree with assignments suggested previously. In some cases it is found that large admixtures of states occur and that no meaningful assignments of parentage or pair-coupling quantum numbers can be made. Calculated positions of energy levels and error estimates are given for some levels which have not been observed. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

18795 THEORETICAL STUDY OF THE ELECTROMAGNETIC COUPLING OF TWO ONE-DIMENSIONAL LAMINAR FLOWS OF AN ELECTRICALLY CONDUCTING VISCOUS LIQUID IN A UNIFORM TRANSVERSE MAGNETIC FIELD. Dorlhac, Francois (College Scientifique Univ., Avignon, France). Compt. Rend., Ser. A; 273: No. 20, 932-5(15 Nov 1971). (In French).

The electromagnetic coupling between two Hartmann flows was studied for different transverse magnetic inductions and ratios between the dimensions. These flows are independent, although they are electrically connected in a direction perpendicular to the flow and to the magnetic induction applied. (France)

18796 UNDAMPED TRANSVERSE HYDROMAGNETIC PLANE WAVES IN A FLUID OF FINITE DIFFUSIVITIES. Takashima, M. (Osaka City Univ.). Phys. Lett.; 38A: No. 2, 75-6(17 Jan 1972).

The possibility of existence of undamped transverse hydromagnetic plane waves in a fluid whose three (viscous, thermal and magnetic) diffusivities are all finite, in the presence of a vertical temperature gradient and a horizontal magnetic field, is predicted. (auth)

18797 EXPERIMENTAL INVESTIGATION OF THE TURBULENT–LAMINAR TRANSITION OF MAGNETOHYDRODYNAMIC FLOW. Gel'fgat, Yu. M.; Kit, L. G.; Tsinober, A. B. (Inst. of Physics, Riga). Dokl. Akad. Nauk SSSR; 199: No. 3, 560-2(21 Jul 1971). (In Russian).

Previous investigations of the suppression of turbulence by a magnetic field were made under conditions in which the ratio of Hartmann to Reynolds numbers (Ha/Re) exceeded a critical value. Experiments were conducted in which Ha/Re was supercritical, and where a constant magnetic field was superimposed on an originally developed turbulent MHD flow. Velocity pulses were completely eliminated for the first time. (K.S.W.)

18798 QUANTUM MECHANICAL CALCULATION OF COLLISION INTEGRALS FOR HD. Koehler, W. E. (Univ., Erlangen, Ger.). Z. Naturforsch.; 26a: No. 11, 1926-8(Nov 1971).

The magnetic Senftleben–Beenakker effect of the viscosity is mainly determined by two collision integrals of the linearized quantum-mechanical Waldmann–Snider collision term, viz. by the relaxation coefficient of the tensor polarization of the molecular rotational angular momenta and by the coefficient that couples the friction pressure tensor and the tensor polarization. Starting from a simple nonspherical potential for HD, the scattering amplitude is evaluated analytically in first-order distorted-wave Born approximation and the two collision integrals are calculated for room temperature. A fairly good agreement with experimental values is found. (auth)

18799 COMMENT ON THE ELECTROHYDRODYNAMIC INSTABILITY IN NEMATIC LIQUIDS. Aslaksen, Erik W. (Brown Boveri Research Center, Baden, Switzerland). J. Appl. Phys.; 43: No. 3, 776-7(Mar 1972).

It is shown that in a nematic liquid carrying an electrolytic current, an infinitesimal stationary distortion of the uniform orientation pattern does not lead to the formation of space charges. This contradicts the basic assumption of the Carr–Helfrich model. (auth)

18800 SOME ASYMPTOTIC EXTREMUM PRINCIPLES FOR MAGNETOHYDRODYNAMIC PIPE FLOW. Smith, P. (Univ. of Keele, Eng.). Appl. Sci. Res. (The Hague); 24: No. 6, 452-66(Oct 1971).

Upper and lower bounds are obtained for the mass flow rate for the steady flow of a conducting liquid along a pipe of arbitrary cross section under the influence of a uniform transverse magnetic field. The extrema are constructed by first establishing an identity which is then used in some simple inequalities. It is shown how these bounds can be used to derive an asymptotic expansion for the flow rate at large Hartmann number. Two illustrations are included. (auth)

18801 ANISOTROPIC WAVE MOTIONS AND THE SURFACE OF A RUNNING STREAM UNDER UNIFORM MAGNETIC AND CURRENT FIELDS. Debnath, L. (East Carolina Univ., Greenville, N. C.). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 19: No. 7-8, 581-8(1971).

A theoretical study is made of anisotropic and dispersive wave motions produced by a harmonic pressure distribution acting on the free surface of an inviscid, incompressible, and electrically conducting fluid in the presence of uniform magnetic and current fields. The generalized function method is employed to solve the problem in a liquid of finite and infinite depth. In both cases an explicit solution of physical interest is established, and its principal features are explored. The solution is found to be singular at the critical speed, and the singular behavior is explained by mathematical and physical arguments. It is shown that the wave motions are anisotropic as well as dispersive, and the anisotropy is entirely due to the imposed MHD force. It is further shown that there are four or two waves propagated in both upstream and downstream directions, depending on whether the basic free-stream speed is subcritical or supercritical. The characteristic features of these waves are discussed. Effects of the imposed magnetic and current fields on the constitutive waves are examined. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 17467.

18802 (IS–2600, pp 211–89) PHYSICS DIVISION. (Ames Lab., Iowa). Dec 1971.

In Ceramic Engineering, Chemical Engineering, Chemistry, Mathematics and Computer Science, Metallurgy, Physics, and Reactor Divisions annual summary research report, July 1970–June 1971.

A summary of research on high-energy, nuclear, and crystal physics is presented. A list of publications is included. (J.F.P.)

18803 (PITHA–54) SEARCH FOR QUARKS IN HIGH-ENERGY AIR SHOWERS. Boehm, A.; Diemont, W.; Faissner, H.; Fasold, H. G.; Krisor, K.; Maull, K.; Sawaf, Z.; Umbach, H. (Technische Hochschule, Aachen (West Germany). Physikalisches Institut (III)). Nov 1971. 17p. Dep. NTIS (U. S. Sales Only).

Quarks of charge e/3 and 2e/3 were searched for in air showers of energies between 10^{13} and 10^{15} eV. A hodoscope of proportional counters was placed under 15 cm Pb. Scintillation counters on top of the lead triggered on high multiplicity showers. No quark was detected in 2120 hours. The upper limit of the quark flux in showers between 10^{14} and 10^{15} eV is, with 90% confidence, 1.0×10^{-10} cm^{-2} sec^{-1} sr^{-1} for either charge. (auth)

18804 WHAT FUTURE FOR MEDIUM-ENERGY PHYSICS? Kolstad, George A. Phys. Today; 25: No. 2, 23-30(Feb 1972).

The discussion of medium-energy physics, which includes all nuclear and particle physics carried out with accelerators or other devices whose primary radiation exceeds 50 but not 1000 MeV, covers cultural viability, impact on other sciences, economic and social values, manpower data, work at LAMPF, funding philosophy, support by AEC, and the future outlook. (J.F.P.)

Electromagnetic

18805 (DESY–71/58) BACKWARD PRODUCTION OF VECTOR MESONS IN INELASTIC ELECTRON SCATTERING. Driver, C.; Heinloth, K.; Hoehne, K.; Hofmann, G.; Karow, P.; Pfeiffer, G.; Schmidt, D.; Specht, G.; Rathje, J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 24p. Dep. NTIS (U. S. Sales Only).

Electroproduction of the vector mesons ρ^0 and ω on protons at backward angles was investigated by measuring the scattered electron and the recoiling proton in coincidence. The differential cross section was determined as a function of W, q^2, $u\text{-}u_{min}$, and φ_V in the following kinematical region: $1.9 \leq W \leq 2.6$ GeV $0.1 \leq |q^2| \leq 0.9$ GeV^2/c^2 $-0.13 \leq u\text{-}u_{min} \leq 0$ GeV^2/c^2 $0^0 \leq \varphi_V \leq 360^0$. (auth)

18806 (DESY–71/64) PHOTOPRODUCTION AND FORBIDDEN DECAYS OF ϕ-MESONS. Alvensleben, H.; Becker, U.; Biggs, P.; Binkley, M.; Busza, W.; Chen, M.; Cohen, K. J.; Coleman, E.; Edwards, R. T.; Mantsch, P. M.; Marshall, R.; Nash, T.; Quinn, D. J.; Rohde, M.; Sadrozinski, H. F. W.; Sanders, G. H.; Schubel, H.; Ting, Samuel C. C.; Wu, Sau Lan (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov 1971. 11p. Dep. NTIS (U.S. Sales Only).

Photoproduction of ϕ mesons on hydrogen and carbon was studied at 5.2 GeV by observing $\phi \rightarrow K^+K^-$ decays. The results show that ϕ's are produced diffractively with a ϕ-nucleon cross section $\sigma_{\phi N} = 9.8^{+2.0}_{-3.5}$ mb. In addition, 80,000 pion pairs were measured to search for the G violating decay $\phi \rightarrow \pi^+\pi^-$. Assuming complete interference between $\rho \rightarrow \pi^+\pi^-$ and $\phi \rightarrow \pi^+\pi^-$, an upper limit of $\Gamma_{\phi\rightarrow 2\pi}/\Gamma_{\phi\rightarrow all} = 2.7 \times 10^{-4}$ was found at the 95% confidence level. (auth)

18807 (LAL–1257) STUDY OF ρ AND THE ω–ρ INTERFERENCE IN THE $\pi^+\pi^-$ MODE. MULTIPION MODE IN VICINITY OF 1 GeV BY e^+e^- ANNIHILATION. Parrour, G. (Paris Univ., Orsay (France). Faculte des Sciences). Dec 1971. 173p. (In French). Dep. NTIS (U.S. Sales Only).

Thesis.

The mass and width of the ρ and the phase of the amplitude for ω–ρ interference are determined in the reaction $e^+ + e^- \rightarrow \pi^+ + \pi^-$ at 990 MeV in colliding beams. Also at the same energy the total cross section is found for $e^+ + e^- \rightarrow \pi^+ + \pi^- + 2\pi^0$ interactions. The partial width of $\rho \rightarrow e^+ + e^-$ decay and the coupling constants $\rho\pi\pi$ are also found. (J.F.P.)

18808 (LAL–1258) PHOTOPRODUCTION OF K^+ MESONS ON THE PROTON. Fourneron, Th. (Paris Univ., Orsay (France). Faculte des Sciences). Dec 1971. 194p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Total and differential cross sections and angular distributions were measured for the reactions $\gamma + p \rightarrow K^+ + \Lambda(\Sigma^0)$ at 940 to 1800 MeV. Upper limits for the cross sections for $\Sigma(1385)$ and $\Lambda(1520)$ and the coupling constant $K\Lambda N$ were also found. (J.F.P.)

18809 STUDY OF HIGH-ENERGY PHOTOPRODUCTION WITH POSITRON-ANNIHILATION RADIATION. I. THREE-PRONG EVENTS. Eisenberg, Y. (Weizmann Inst. of Science, Rehovoth, Israel); Haber, B.; Ronat, E. E.; (and others). Phys. Rev., D; 5: No. 1, 15-38(1 Jan 1972).

The photoproduction of resonances was studied in three exposures of a hydrogen bubble chamber to positron-annihilation radiation of 4.3-, 5.25-, and 7.5-GeV nominal energies. The general analysis procedure and results on the three-prong-event topology are presented. The highly constrained reaction $\gamma p \rightarrow p\pi^+\pi^-$ over the energy range 2 to 8 GeV and the reactions $\gamma p \rightarrow p\pi^+\pi^-\pi^0$ and $\gamma p \rightarrow n\pi^+\pi^+\pi^-$ at the annihilation energies are studied. Cross sections are given. Using various models to parametrize the ρ^0 "elastic" reaction the mean t slope is found to be 7.1 ± 0.4 GeV^{-2} and its forward cross section is found to decrease from 130 μb GeV^{-2} at 3.3 GeV to ~100 μb GeV^{-2} at 7.5 GeV. The cross section for $\gamma p \rightarrow \omega p$ is decomposed into one-pion exchange (OPE) and a diffractive part, $\sigma_D(\omega)$, which is found to be 1.5 ± 0.3 μb. $\sigma(\rho^0)/\sigma_D(\omega)$ is then 9.5 ± 2.3. In comparing vector-meson production with Compton scattering via vector-meson dominance, it is found that for $\gamma_\rho^2/4\pi = 0.32 \pm 0.03$ there is good agreement at all s and t where comparison may be made ($E_\gamma = 5-8$ GeV). In a search for $\rho' \rightarrow 2\pi$, at the 90% confidence level, $\sigma_{\rho'(1250)} < 0.3$ μb and $\sigma_{\rho'(1650)} < 0.1$ μb per 100-MeV width were found. Inelastic peripheral ρ^0 production is seen, but with present statistics specific nucleon isobars associated with it could not be identified. Quasi-two-body reactions $\gamma p \rightarrow \pi^-\Delta^{++}$, $\rho^-\Delta^{++}$, and A_2^-n are observed, decreasing with photon energy like E_γ^{-a}. For the first two $a = 1.74 \pm 0.16$ and 0.6 ± 0.2, respectively are found. It is concluded that if the reaction $\gamma p \rightarrow \rho^-\Delta^{++}$ is due to an OPE process, the required $\rho \rightarrow \pi\gamma$ width (~0.5 MeV) is much in excess of the value predicted by SU(3). (auth)

18810 DIRECT CHECK OF QED IN e^+e^- INTERACTIONS AT HIGH q^2-VALUES. Alles-Borelli, V.; Bernardini, M.; Bollini, D.; (and others) (CERN, Geneva. Istituto Nazionale di Fisica Nucleare, Bologna. Univ., Bologna. Laboratori Nazionali, Frascati, Italy). Nuovo Cim.; 7A: No. 2, 345-62(21 Jan 1972).

A study of 1824 $e^+e^- \rightarrow e^\pm e^\mp$ events in the total center-of-mass energy range from 1.6 GeV to 2.0 GeV, establishes that production angular distributions, a collinearity and acoplanarity distributions, and absolute value of the cross sections and their energy-dependence, follow QED predictions including first-order radiative corrections. In particular, the absolute value of the cross section and the power of its energy-dependence agree with theoretical expectations within ±6% and ±2%, respectively. The inadequacy of the peaking approximation in our experimental conditions of observations has been measured to be (2.8 ± 0.4)%. (auth)

18811 CHECK OF QUANTUM ELECTRODYNAMICS AND OF ELECTRON–MUON EQUIVALENCE. Alles-Borelli, V.; Bernardini, M.; Bollini, D.; (and others) (CERN, Geneva. Istituto Nazionale di Fisica Nucleare, Bologna. Univ., Bologna. Laboratori Nazionali, Frascati, Italy). Nuovo Cim.; 7A: No. 2, 330-44(21 Jan 1972).

A study of the timelike reaction $e^+e^- \rightarrow \mu^\pm\mu^\mp$ and of its comparison with the spacelike dominated reaction $e^+e^- \rightarrow e^\pm e^\mp$ allows the validity of QED to be established in terms of production angular distributions, absolute rates, energy dependence and angular correlations between the pair of final-state leptons, in two very different ranges of invariant four-momentum transfer. No sign of QED break is detected in the electromagnetic interactions of leptons and the muon behaves like a heavy electron, within the accuracy of the present investigation. (auth)

18812 UPPER LIMIT OF THE ISOTENSOR CONTRIBUTION TO THE ELECTROPRODUCTION CROSS SECTION IN THE REGION OF THE DELTA(1236)-RESONANCE. Bleckwenn, J. (Deutsches Elektronensynchrotron, Hamburg); Moritz, J.; Schmidt, K. H.; Wegener, D. Phys. Lett.; 38B: No. 4, 265-8(21 Feb 1972).

The cross section for electroproduction on protons and neutrons was investigated. For momentum transfers 0.1 $(GeV/c)^2 < q^2 < 0.5$ $(GeV/c)^2$ and invariant masses $W < 1.4$ GeV of the final hadronic

state the measured cross section was split up into a resonant and a nonresonant contribution. The transition form factor $G^{*}_{Mn}(q^2)$ of the $\gamma n\Delta$-vertex is derived from the resonant cross section. The equality of the resonant part of the excitation cross section on neutrons and protons allows an upper limit of 7% to be derived for the isotensor component to the electroproduction process. (auth)

18813 DOUBLE-PION PHOTOPRODUCTION OFF PROTONS BELOW 1 GeV. Kusumegi, A. (Tokyo Univ.); Mishina, M.; Murata, Y.; (and others). Nuovo Cim.; 7A: No. 4, 727-52(21 Feb 1972).

Measurements of the energy spectra and the excitation yields of π^- and π^+, from the reactions $\gamma + p \rightarrow \pi^- + \pi^+ + p$ and $\gamma + p \rightarrow \pi^+ + \pi^0 + n$ together, were done at a laboratory angle 58.2° with bremsstrahlung maximum energies up to around 1 GeV, using the 1.3 GeV electron synchrotron. The differential cross sections were derived and compared with a simple isobar model. The results show that, while the energy spectra and the excitation yields of π^- agree with the model of the $T = 1/2$ isobar excitation decaying into $\Delta + \pi$ as well as with the existing data, those of π^+ show some discrepancy with the same model. Discussions are given to explain the particular feature of π^+ distributions observed in the present experiment. (auth)

18814 ELECTROPRODUCTION EXPERIMENTS. Brasse, F. W. (Deutsches Elektronen-Synchrotron, Hamburg). J. Phys., A (London); 5: No. 1, 1-26(Jan 1972).

A survey is given for recent experiments in electroproduction and a discussion of their results. For the resonance region the main results are that the ratio of longitudinal to transverse excitation is about as small as it was found for the deep inelastic continuum (about 0.2 or smaller). The excitation of the $\Delta(1236)$ in the π^0 channel, as measured by coincidence techniques, is going mainly through M_{1+}. However, other small contributions like S_{1+} and E_{1+} for the resonant part and E_{0+} and M_{1-} for the nonresonant part are not negligible. In the deep inelastic region coincidence measurements are reported. Single positive pion production on hydrogen shows a large longitudinal cross section, which can be explained quite well by vector meson dominance. Proton momentum spectra in the direction of the virtual photon do not show an unusually large flux of protons with high momenta as was expected from a specific parton model. (auth)

Weak

18815 (COO-1195-230) SEARCH FOR DIRECT PROCESSES IN $K^{\pm} \rightarrow \pi^{\pm}\pi^0\gamma$ DECAYS. Edwards, R. T.; Beier, E. W.; Bertram, W. K.; Herzo, D. P.; Koester, L. J.; Wattenberg, A. (Illinois Univ., Urbana. Dept. of Physics). Dec 1971. 25p. Dep. NTIS.

There were 33 events of the type $K^+ \rightarrow \pi^+\pi^0\gamma$ and 31 of the type $K^- \rightarrow \pi^-\pi^0\gamma$ found in an experiment using spark chambers. The angles of the observed decay products were used to determine the angle between the charged pion and the γ-ray in the K rest frame. The distribution of this angle showed no indication of a direct radiative process but instead was consistent with internal bremsstrahlung. In order to be quantitative concerning the amount of direct interaction, 24 events with the charged pion kinetic energy T_π restricted to 58 MeV $\leq T_\pi \leq$ 90 MeV were selected, and maximum likelihood fits were carried out for various assumptions regarding the radiative amplitudes, final state interaction, and amount of CP violation. Assuming no magnetic dipole, the largest value found by the maximum likelihood fit for the direct (electric dipole) amplitude is $A_E = -0.12^{+0.21}_{-0.16}$ relative to the internal bremsstrahlung amplitude. If the direct process occurs, and if CP is appreciably violated in the $K^{\pm} \rightarrow \pi^{\pm}\pi^0\gamma$ decay, there would be a difference between the rates for $K^+ \rightarrow \pi^+\pi^0\gamma$ and $K^- \rightarrow \pi^-\pi^0\gamma$. The result is $[\Gamma(K^- \rightarrow \pi^-\pi^0\gamma)/\Gamma(K^+ \rightarrow \pi^+\pi^0\gamma)] - 1 = 0 \pm 0.24$. Thus a large asymmetry suggested by some theories is ruled out by this observation. (auth)

18816 MEASUREMENT OF THE RATIO AXIAL VECTOR TO VECTOR COUPLING CONSTANT $|g_1/f_1|$ IN $\Lambda \rightarrow p\, e^-\, \bar{\nu}$ DECAY. Baggett, M.; Baggett, N.; Eisele, F.; (and others) (Univ., Heidelberg). Z. Phys.; 249: No. 4, 279-85(1972).

In a stopping K^- exposure in the Saclay 81-cm hydrogen bubble chamber, a sample of 352 kinematically determined $\Lambda \rightarrow p\, e^-\, \bar{\nu}$ decays was obtained. From the electron-neutrino angular distribution of these events, the ratio of the axial vector to vector coupling constants $|g_1/f_1|$ was found to be $0.74^{+0.09}_{-0.11}$. This result is in good agreement with Cabibbo's theory. The method of analysis is insensitive to the relative strength of weak magnetism. (3 figures, 1 table) (auth)

18817 COINCIDENCE ELECTROPRODUCTION IN THE REGION OF THE ρ MESON. Bloom, E. D.; Cottrell, R. L. A.; DeStaebler, H.; (and others) (Stanford Univ., Calif.). Phys. Rev. Lett.; 28: No. 8, 516-19(21 Feb 1972).

Cross sections for the reaction $ep \rightarrow epX^0$, measured by detecting both the scattered electron and the proton, are given for missing masses m_X between 0 and 1 GeV/c^2. Enhancements are observed at $m_X = 0$ and in the region of the ρ meson at $q^2 = 0.1$ and 0.5 (GeV/c)^2. The electroproduction of all states with m_X between 0.7 and 0.83 GeV/c^2 varies like $e^{-7.5t}$ for $q^2 = 0.1$ (GeV/c)^2, similar to missing-mass photoproduction, but for $q^2 = 0.5$ (GeV/c)^2 it varies like $e^{-3.5t}$. In this mass region the resolution tail of the large bremsstrahlung peak at $m_X = 0$ is small. (auth)

18818 ENERGY SPECTRUM AND ANGULAR DISTRIBUTION OF COSMIC RAY MUONS IN THE RANGE 50 TO 70 GeV. Bedewi, Fel; Goned, A.; Girgis, A. H. (Ein Shams Univ., Cario). J. Phys., A (London); 5: No. 2, 292-302(Feb 1972).

The energy dependence and angular distribution of the sea level muon intensity were determined from measurements made inside the second pyramid at Giza, Cairo. It is concluded from these measurements that the sea level muon integral spectrum may be represented in the energy range 50 to 70 GeV by the power law $I(E,\theta) = KE^{-2.09}(\cos\theta)^{-0.62}$ where E is expressed in GeV, θ is the angle to the vertical and K is a constant. The above values of energy and cosine exponents are found to be in agreement with those calculated using the CKP interaction model if pions are assumed to be the parents of the majority of muons reaching sea level with energies in the range considered. Calculations made for various energies using this model also show general accordance with the experimental results of other authors. This indicates further support for the application of the model to primary interactions at high energies. (auth)

Strong (Baryon-induced)

Refer also to abstract 18855.

18819 (ANL/HEP-7107, pp 1-34) PROTON-PROTON INTERACTIONS BETWEEN 90 AND 800 GeV/c: EXPERIMENTAL RESULTS FROM ECHO LAKE COSMIC RAY STUDIES. Lyon, Donald E. Jr. (Michigan Univ., Ann Arbor). 19 Nov 1970.

From Talks presented at the symposium on high energy interactions and multiparticle production.

A summary is given of p + p interaction properties measured for the energy range 90 to 800 GeV/c. The various distributions and cross sections are given. For this experiment cosmic particles were used as the beam interacting in a liquid hydrogen target. (J.F.P.)

18820 (CERN-71-25) LOW-MOMENTUM ANTIPROTON PRODUCTION AT THE CERN PROTON SYNCHROTRON. Kalmus, P. I. P.; Eisenhandler, E.; Gibson, W. R.; (and others) (European Organization for Nuclear Research, Geneva (Switzerland)). 26 Nov 1971. 15p. Dep. NTIS (U. S. Sales Only).

Yields of antiprotons produced at a laboratory angle of 310 milliradians from an internal beryllium target in the CERN Proton Synchrotron (PS) were measured. Antiprotons were identified by a time-of-flight system. The measurements were made during two short periods in the m_{11} beam-line, and covered the momentum range from 0.6 to 2.4 GeV/c. The momentum of the circulating beam was 26 GeV/c during the first run and 24 GeV/c during the second. Yields in a fixed percentage momentum bite are approximately constant at the high end of the momentum range, and then fall steeply with decreasing momentum. Some additional information about the performance of the beam is also presented. (auth)

18821 (FRNC-TH-130) METHOD FOR ANALYZING A BUBBLE CHAMBER EXPERIMENT. STUDY OF THE $\bar{p}p \rightarrow K\bar{K}\, n\pi$ ANNIHILATIONS AT 2.5 GeV/c FOR n BETWEEN 1 AND 5. Bonnet, Alain (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 217p. (In French). Dep. NTIS (U.S. Sales Only).

Thesis.

Two different types of improvement were made to facilitate the analysis of bubble chamber experiments: the development of a method for systematically determining the external errors, which must be included in the kinematic analysis (GRIND program); the JUDGE program, which deals with the processing of data from GRIND (mass hypothesis). This latter program enabled the control unit of the photographic processing system to be automated. The $\bar{p}p \rightarrow K\bar{K}\, n\pi$ reactions were studied at 2.5 GeV/c for values of n ranging between 1 and 5; the cross sections were determined for the various channels and the K^*, ρ, ω, and η resonances. A phenomenological study of the channels based upon the p_l and p_t distributions of the momenta of the final state particles, and the angular correlations (Goldhaber effect) was made. Exchange mechanisms are demonstrated using the longitudinal phase space

method. A simple parametrization of the transverse and the longitudinal momenta was obtained using a thermodynamic model. (France)

18822 (LAL-1259) MEASUREMENT OF DIFFERENTIAL CROSS SECTION FOR PRODUCTION OF π AND K MESONS ON ALUMINUM AND BERYLLIUM TARGETS AT 24 GeV/c. Aubert, B.; Chounet, L. M.; Heusse, Ph. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Dec 1971. 17p. (In French). Dep. NTIS (U. S. Sales Only).

A experiment for the measurement of the differential cross sections for the production of π^+, π^-, K^+, and K^- in proton reactions with aluminum and beryllium at 24 GeV/c is described. A spectrometer is used for this study. (J.F.P.)

18823 INCLUSIVE N-BODY REACTION IN NUCLEON–NUCLEON INTERACTIONS AT ULTRAHIGH ENERGIES. Jain, P. L.; Ahmad, Z. (State Univ. of New York, Buffalo). Phys. Rev. Lett.; 28: No. 7, 459-61(14 Feb 1972).

Inclusive reactions for multiparticles produced from cosmic-ray emulsion data at ~10^{12} eV are presented and are compared with the predictions of limiting-fragmentation distribution. (auth)

18824 POLARIZATION IN ELASTIC ANTIPROTON–PROTON SCATTERING BETWEEN 0.9 AND 2.5 GeV/c. Albrow, M. G.; Andersson-Almehed, S.; Bosnjakovic, B.; (and others) (CERN, Geneva). Nucl. Phys.; B37: No. 2, 349-63(1972).

Polarization and differential-cross-section data are presented for elastic scattering of antiprotons on polarized protons at eight momenta between 0.9 and 2.5 GeV/c. The data are fitted with a diffraction model. (auth)

18825 ANALYSIS OF THE REACTION $pd \rightarrow pd\pi^+\pi^-$ AT 7 GeV/c. Karshon, U.; Yekutieli, G.; Yaffe, D. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; B37: No. 2, 371-80 (1972).

The coherent production of the final state $pd\pi^+\pi^-$ is studied in pd interactions at 7 GeV/c. The reaction is dominated by strong production of $\Delta^{++}(1236)$ and by a low-mass $d\pi^-$ enhancement (d^*) at ~2200 MeV. The pure $I = \frac{1}{2}$ $p\pi^+\pi^-$ spectrum shows a significant narrow peak at ~1470 MeV lying on a small background. A double-Regge fit describes the low mass region on the average, but does not reproduce the narrow peak. (auth)

18826 NEGATIVE PARTICLE PRODUCTION AT THE CERN INTERSECTING STORAGE RINGS. Bertin, A.; Capiluppi, P.; Cristallini, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Phys. Lett.; 38B: No. 4, 260-4(21 Feb 1972).

Preliminary results on the production of negative particles in inclusive reactions at intermediate angles (80 to 200 mrad) at the CERN ISR are reported. Pion production is still the dominant process; within experimental errors, scaling holds for negative pions or alternatively a limiting distribution is reached at relatively low energies. However, the antiproton production cross sections are apparently larger than smaller energies. (auth)

18827 RESEARCH AT SERPUKHOV. Solov'ev, L. D. CERN Cour.; 11: No. 11, 315-19(Nov 1971).

A summary of research on strong interactions is given. Total cross sections and the diffraction cone slope, differences of total cross sections and the charge-exchange process, elastic scattering amplitude and polarization effects, inelastic processes, and progress with bubble chambers are covered. The operation of the accelerator is also discussed. (J.F.P.)

18828 EXPERIMENTAL TEST OF TIME REVERSAL INVARIANCE IN THE REACTION $n + p \rightarrow \gamma + d$. Schrock, Bryce Leon. Los Angeles; Univ. of California (1971). 155p. University Microfilms Order No. 72-2900.

Thesis.

A measurement of the angular distribution for the reaction $n + p \rightarrow \gamma + d$ was made at Lawrence Radiation Laboratory 184-inch cyclotron for neutron kinetic energies in the range 300 to 720 MeV. A total of 30,000 $n + p \rightarrow \gamma + d$ events were collected in 20 energy-angle bins. A comparison with the angular distribution for the inverse process indicates that the data are consistent with time-reversal invariance in this reaction. If the results are interpreted in the framework of a model by S. Barshay, the measured T-violating phase angle is $\phi = (4 \pm 10)°$ where $\phi = 90°$ for a maximal T-violation.

Strong (Meson-induced)

Refer also to abstracts 17869 and 17870.

18829 (ANL/HEP-7107, pp 93-143) MULTIPARTICLE PRODUCTION: A REVIEW OF THE SALIENT FEATURES OF ACCELERATOR DATA. Smith, Gerald A. (Michigan State Univ., East Lansing). 19 Nov 1970.

From Talks presented at the symposium on high energy interactions and multiparticle production.

The review of multiparticle production covers inclusive and exclusive experiments, models, and prospects for experiments at high energy. The π^- + p and p + p interactions are considered. (J.F.P.)

18830 (CEA-N-1496) STRANGE-PARTICLE PRODUCTION IN π^-p INTERACTIONS AT 11.1 GeV/c. Vincent, Marc-Aurele (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1971. 161p. (In French). Dep. NTIS (U.S. Sales Only).

Thesis. Submitted to Univ. of Paris, France.

The 88,000 pictures taken in the B.H.B.C. of 1.50m and in the C.B.H. of 2.00 m at the CERN proton synchrotron were studied. The problems encountered in collecting strange particle events at high energy are presented. Total cross sections, and partial cross sections of 45 individual reactions, and the result of a systematic inventory of known resonances produced in 10 reactions and in the $Y^0K^0_1$ and $K^0_1K^0_1$ systems, are given. The peripherism of the reactions was studied. (France)

18831 (CERN/HERA-71-1) SELECTIVE COMPILATION OF $\pi^-p \rightarrow \pi\pi N$ EVENTS FROM HYDROGEN BUBBLE CHAMBERS. Jacobs, L. D.; Roos, M.; Santiago, S. (European Organization for Nuclear Research, Geneva (Switzerland)). 20 Sep 1971. 116p. Dep. NTIS (U. S. Sales Only).

Sixteen hydrogen bubble-chamber experiments on the reaction $\pi^-p \rightarrow \pi\pi N$ at beam momenta 1.7 to 3.2 GeV/c are compiled in the form of fitted events (four-vectors) on a data summary tape. The experiments are tested mutually for consistency. Consistent data are added to give a numerical Chew-Low table, graphs and tables of spherical moments as functions of beam momentum and dipion mass, and numerical tables of cos $\theta_{\pi\pi}$ versus azimuth as a function of dipion mass. (auth)

18832 (FRNC-TH-122) $K^-d \rightarrow \Lambda^0 n$ AND $K^-d \rightarrow \Sigma^- p$ REACTIONS AROUND 1 GeV/c. Noppe, Jane (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 79p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The $K^- + d \rightarrow Y + N$ reactions were analyzed in the framework of a general study of the $K^- + N$ interactions in the 1-GeV/c region. The total cross sections were determined for the $K^- + d \rightarrow \Sigma^- + p$ (about 55 μb) and $K^- + d \rightarrow \Lambda^0 + n$ (about 100 μb) reactions, between 700 and 1,200 MeV/c. The order of magnitude of the differential cross sections was obtained. The Schillaci and Silbar theory using the π or K meson exchange model is applied to this energy region. The differential cross sections are expressed in terms of the coupling constants, parameters of the deuterium wave function, diffusion cross sections, and the Ferrari–Selleri form factor. The experimental results obtained are compared with those derived from the theory. (France)

18833 (JINR-P1-6197) ESTIMATION OF THE PION AND NUCLEON FORM FACTORS AT $k^2 = 2f^{-2}$ FROM ANALYSIS OF THE $\pi^-p \rightarrow e^+e^-n$ REACTION AT THE PION KINETIC ENERGY 275 MeV. Berezhnev, S. F.; Vertogradov, D. S.; Dem'yanov, A. V.; Kulikov, A. V.; Kuptsov, A. V.; Mkrtchyan, G. G.; Nemenov, L. L.; Smirnov, G. I.; Khazins, D. M.; Chirkin, Yu. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The first experimental data on the $\pi^-p \rightarrow e^+e^-n$ reaction in the $\Delta(1230)$ resonance region were reported previously. An analysis of the measured cross sections using previous theoretical calculations is given. Such an analysis can extract information on the pion and nucleon form factors in the time like region of virtual photon four-momentum transfers. Theoretical predictions of the previous work are based on dispersion energy calculations of Fubini, Numou and Wataghin. It is shown that the Born terms give the main contribution to the cross section. Interference between Born terms and magnetic dipole transition amplitude almost completely cancels the isobar contribution. These two facts allow, in principle, a precision of theoretical description not worse than 10% to be obtained. Experimental data on total and differential cross sections agree well with the theory. The theory is sensitive to the pion electric form factor F_π and the isovector Dirac-nucleon form factor F_1^V, but is absolutely insensitive to the isovector nucleon magnetic form factor G_m^V. It is assumed that F_π and F_1^V are real all over the region of momentum transfers $0.75\ f^{-2} < k^2 < 3\ f^{-2}$. The following upper bound limits of form factors at $k^2 = 2\ f^{-2} = 0.078$ (GeV c)^2 are obtained: $F_1^V < 1.3$, $F_\pi < 1.25$

(1 st. deviation) and $F_1^V < 1.44$, $F_\pi < 1.35$ (2 st. deviations). Assumptions concerning one of these form factors give: if $F_\pi = (1-k^2/m_\pi^2)^{-1} = 1.15$ then $F_1^V = 0.7$ to 1.2, if $F_\pi = F_1^V$ then $F_\pi = F_1^V = 1.07^{+0.10}_{-0.07}$. It is shown that analysis of the angular distributions with better statistics allows one to obtain better precision in form factors determination. (auth)

18834 (NP-19165) MEASURE OF THE POLARIZATION PARAMETER IN ELASTIC REACTIONS BETWEEN 6 AND 17.5 GeV/c BY USE OF A TARGET OF POLARIZED PROTONS. Olivier, Jean-Claude (European Organization for Nuclear Research, Geneva). 1971. 119p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Eidgenoessische Technische Hochschule, Zurich (Switzerland).

Polarization is reported for the elastic scattering $\pi^+ + p$, $\pi^- + p$, and $p + p$ at 6, 10, 14, and 17.5 GeV/c and for $K^+ + p$, $K^- + p$, and $\bar{p} + p$ at 6, 10, and 14 GeV/c; a few differential cross sections are also given. The experimental setup and data handling are described. Regge-pole models are used for most of the theoretical analysis. (33 figures, 16 tables) (R.W.R.)

18835 (ORO-3956-72-1) BUBBLE CHAMBER STUDIES OF HADRON AND PHOTON INTERACTIONS. Progress Report, June 1, 1971-May 31, 1972. Bugg, W. M.; Condo, G. T.; Hart, E. L. (Tennessee Univ., Knoxville). Contract AT(40-1)-3956. 4p. Dep. NTIS.

A summary of research on strong interactions in a bubble chamber is presented. A list of publications is included. (J.F.P.)

18836 (PCCF-RI-71/7) ELEMENTARY PARTICLE PHYSICS LABORATORY OF CLERMONT-FERRAND. Annual Report, April 1970-April 1971. (Clermont-Ferrand Univ. (France). Laboratoire de Physique Corpusculaire). 1971. 26p. (In French). Dep. NTIS (U. S. Sales Only).

Three main topics are studied at the elementary particle physics laboratory at Clermont-Ferrand: hadron coherent scattering by light nuclei, pion interactions at low energy, the effect of heavy ions on condensed media. Two investigations currently being undertaken on electron quasi-elastic scattering and high energy muon-production will be terminated in the near future. The work is carried out in conjunction with important national research centers, and government and private laboratories in the region. A list of publications is included. (France)

18837 K^+N CHARGE-EXCHANGE SCATTERING AT 1.94 GeV/c. Davies, D. W. (Univ. of California, Los Angeles); Poster, P. E.; Schlein, P. E.; (and others). Phys. Rev., D; 5: No. 1, 1-4(1 Jan 1972).

Experimental results are presented on the reaction $K^+n \rightarrow K^0p$ at 2 GeV/c. As required by strong ρ-A_2 exchange degeneracy, the $d\sigma/dt$ distribution shows no structure at $t \propto -0.6$ $(GeV/c)^2$. The $d\sigma/du$ distribution for backward charge-exchange scattering does not agree with proposed I = 0 baryon-exchange models. (auth)

18838 OBSERVATION OF THREE NARROW NEUTRAL MESONS IN THE VICINITY OF 950 MeV. Cheshire, D. L. (Iowa State Univ., Ames); Jacobel, R. W.; Lamb, R. C.; (and others). Phys. Rev. Lett.; 28: No. 8, 520-3(21 Feb 1972).

Two narrow, neutral mesons, in addition to the well-established $\eta'(958)$, were observed in the reaction $\pi^-p \rightarrow M^0n$ at 2.4 GeV/c in a scintillation-counter experiment. A mass of 940.5 ± 1.7 MeV, $\Gamma <$ 10.4 MeV was observed for the $M^0(940)$; and a mass of 962.9 ± 1.7 MeV, $\Gamma <$ 5.9 MeV, for the δ^0. (auth)

18839 TEST OF HELICITY CONSERVATION AND SPIN-PARITY ANALYSIS OF THE N*(1700). Lamsa, J. W. (Purdue Univ., Lafayette, Ind.); Willmann, R. B.; Ezell, C. R.; (and others). Nucl. Phys.; B37: No. 2, 364-70(1972).

The diffractively produced low-mass $\pi^+\pi^-p$ system is studied in the reaction $\pi^+p \rightarrow \pi^+\pi^+\pi^-p$. Strong N*(1700) production and determine the branching fraction to $\pi^-\Delta^{++}$ to be 65 ± 15%. A spin-parity analysis (assuming $J < 7/2$) yields $J^P = 5/2^+$ for the N*(1700). The study of the decay angular distribution of the N*(1700) indicates that helicity is conserved in the t-channel rather than in the s-channel. (auth)

18840 SHIELDED FIXED-POLE POMERANCHON MODEL FOR HIGH ENERGY TOTAL AND DIFFERENTIAL CROSS SECTIONS. Barnett, R. Michael (Argonne National Lab., Ill. Univ. of Chicago). Nucl. Phys.; B37: No. 2, 381-400(1972).

A Regge model with a fixed-pole Pomeranchon and its associated shielding cut is used for $\pi^\pm p$, $K^\pm p$ and pp scattering at small t and from 6 GeV to NAL and ISR energies. No additional parameters are associated with the cut. The model produces rising total cross sections and anti-shrinkage or nonshrinking diffraction peaks for some s and t. Good fits to total cross sections and to Serpukhov and ISR pp slope parameter data are obtained, and predictions about cross sections and shrinkage at NAL energies are made. (auth)

18841 SEARCH FOR EXOTIC MESONS PRODUCED BY BARYON EXCHANGE AND $\bar{B}B$ COUPLING TO EXOTIC CHANNELS. Buhl, T.; Cline, D.; Terrell, R. (Univ. of Wisconsin, Madison). Nucl. Phys.; B37: No. 2, 421-8(1972).

Recent evidence on exotic meson exchange reactions suggests that such mesons, if they exist, may couple strongly to baryon-decuplet vertices. Therefore, decuplet baryon-exchange reactions provide the "natural" searching grounds for these states. A search was made for possible J = 0, 2, I = 2 states in the mass range of 0.9 to 1.3 GeV/c using the reaction $\pi^-p \rightarrow p + x^-$. Recent backward data from the reaction $\pi^+n \rightarrow p + \pi^+ + \pi^-$ are shown for comparison. It is tentatively concluded that the baryon-decuplet annihilation vertex shows strong coupling to the I = 2 $\pi\pi$ system. (auth)

18842 SEARCH FOR Ξ^* RESONANCES IN K^-p INTERACTIONS AT 3.95 GeV/c. Badier, J.; Barrelet, E.; Charlton, G. R.; Videau, I. (Ecole Polytechnique, Paris). Nucl. Phys.; B37: No. 2, 429-43(1972).

A 12-event/μb bubble chamber experiment on K^-p interactions at 3.95 GeV/c yielded 1212 events including systems with strangeness S = -2. Results concerning cascade resonances with masses less than 2000 MeV are reported; in particular a determination of the mass and width of the $\Xi^0(1530)$ and an interpretation of the mass region (1700 to 2000) MeV. (auth)

18843 ELASTIC AND INELASTIC SCATTERING OF 385 MeV/c PIONS BY ^{16}O. Rohlin, J. (Chalmers Tekniska Hoegskola, Goteborg); Rohlin, S.; Allardyce, B. W.; (and others). Nucl. Phys.; B37: No. 2, 461-76(1972).

The scattering of positive pions by ^{16}O was studied using a magnetically analyzed beam of 385-MeV/c pions and a magnetic spectrometer for the scattered pions. Full inelastic spectra were recorded at four angles and the elastic scattering at twenty angles. The elastic scattering is compared with calculations made in the Glauber approximation. The Glauber calculations fit the experimental data extremely well. (auth)

18844 STUDY OF THE REACTION $\pi^-p \rightarrow \bar{p}d$ AT 5 GeV/c. Baglin, C. (Ecole Polytechnique, Paris); Briandet, P.; Carlson, P. J.; (and others). Nucl. Phys.; B37: No. 2, 639-43(1972).

The differential cross section for the reaction $\pi^-p \rightarrow \bar{p}d$ was measured at 5 GeV/c in the interval $0.55 < -t < 2.5$ $(GeV/c)^2$, corresponding to the c.m. angular range $17° < \theta_{\pi^-p} < 87°$. The cross section is found to be roughly constant with an average value of 0.1 $\mu b/(GeV/c)^2$. Assuming isotropy over the whole angular range, a total cross section 0.6 ± 0.2 μb is deduced. This agrees with the extrapolated cross section value for the inverse reaction $\bar{p}d \rightarrow p\pi^-$. (auth)

18845 PRODUCTION OF SIX-CHARGED PARTICLES IN π^-p INTERACTIONS AT 7 GeV/c. Berenyi, P. L. (Univ. of Toronto); Prentice, J. D.; Steenberg, N. R.; Yoon, T. S.; Walker, W. D. Nucl. Phys.; B37: No. 2, 621-38(1972).

Events with six charged particles produced in a hydrogen bubble chamber by a 7-GeV/c π^- beam, are analyzed. In the $\pi^-p \rightarrow p2\pi^+3\pi^-$ channel strong production of ρ^0 and Δ^{++} is observed. The A_1^- and A_2^- mesons are also produced. The c.m. opening angle distributions between pion pairs are presented and the differences between like and unlike pion pairs are shown to agree with the Goldhaber model predictions. In the $\pi^-p \rightarrow p2\pi^+3\pi^-\pi^0$ channel the Δ^{++}, ω^0, η^0 X^0 resonances are observed. There is also evidence for the $D^0 \rightarrow \eta^0\pi^+\pi^-$ decay. Single particle distributions are also presented and compared with the predictions of phenomenological models proposed by Chan, Loskiewicz and Allison and by Zieminski. (auth)

18846 POLARIZATION IN ELASTIC π^-p SCATTERING AT 16 MOMENTA BETWEEN 865 AND 2732 MeV/c. Albrow, M. G.; Andersson-Almehed, S.; Bosnjakovic, B.; (and others) (CERN, Geneva). Nucl. Phys.; B37: No. 2, 594-620(1972).

Polarization distributions and differential cross section data for elastic scattering of negative pions on protons between 865 and 2732 MeV/c are presented. They are compared with published phase-shift analyses. (auth)

18847 K^+d INTERACTIONS BETWEEN 0.6 AND 1.5 GeV/c. Giacomelli, G. (Univ., Bologna. INFN, Bologna); Lugaresi-Serra, P.; Mercatali, F.; (and others). Nucl. Phys.; B37: No. 2, 577-93(1972).

A bubble chamber experiment is described in which observations were made of positive kaon interactions in deuterium. Partial cross sections are given at 13 kaon momenta in the range

0.64 to 1.51 GeV/c. The computation of the free-neutron partial inelastic cross sections is discussed. From these results and from previously measured K^+p data the $(K^+N)_{I=0}$ partial cross sections are derived. (auth)

18848 $\Xi\pi$ RESONANCE WITH MASS 1606 MeV/c^2. Ross, R. T.; Buran, T.; Lloyd, J. L.; Mulvey, J. H.; Radojicic, D. (Oxford Univ.). Phys. Lett.; 38B: No. 3, 177-80(7 Feb 1972).

Evidence is found for a strangeness −2 baryon resonance ($\Xi^-\pi^+$) with mass 1605.5 ± 5.6 MeV/c^2 and width 20.8 ± 7.4 MeV/c^2 in the reaction $K^-p \rightarrow \Xi^-\pi^+K^0$ (890) at the K^- momenta 3.13, 3.30 and 3.58 GeV/c. The data come from several exposures of the CERN 2m hydrogen bubble chamber. (auth)

18849 CHANNEL CROSS-SECTIONS OF K^-p REACTIONS FROM 1.26 TO 1.84 GeV/c. De Bellefon, A. (College de France, Paris); Berthon, A.; Rangan, L. K.; (and others). Nuovo Cim.; 7A: No. 3, 567-83(1 Feb 1972).

The results on total channel cross sections obtained in the Saclay 180 l HBC exposed to a separated K^- beam at Nimrod are presented. The cross sections for each channel are given at 13 incident K^- momenta between 1.26 and 1.84 GeV/c. (auth)

18850 FINAL STATES WITH A VISIBLE $\overline{K}^0$ IN K^-d INTERACTIONS AT 3.4 GeV/c. Eckert, R, R.; Kwak, N.; Nicholas, M.; Stump, R. (Univ. of Kansas, Lawrence). Nuovo Cim.; 7A: No. 3, 605-31(1 Feb 1972).

K^-d interactions at 3.4 GeV/c were investigated for the neutron target and coherent deuteron reactions in which a $\overline{K}^0$-meson is produced. The cross sections, effective masses, and angular distributions are presented. The dominant feature for all final states is the significant production of the K*(890). The spin-density matrices of the K*(890) and Δ(1238) for the $\overline{K}^0\pi^-n$ final state indicate that a vector-meson exchange is an important mechanism. (auth)

18851 IS THERE STRUCTURE IN THE f^0 MASS REGION? Kemp, D. (Univ. of Durham, Eng.); Major, J. V.; Scarrott, S. M.; (and others). Lett. Nuovo Cim.; 3: No. 7, 257-60(12 Feb 1972).

A possible structure in the f^0 mass region was observed in the reaction $\pi^+d \rightarrow \rho_s\rho\pi^+\pi^-$ interaction from an exposure to 11.7 GeV/c pions in the CERN 2m chamber. The dipion mass spectrum was fitted by a single S-wave Breit–Wigner distribution function and a dipole distribution function. It is concluded that the dipole fit was not markedly better than the Breit–Wigner fit. (L.B.S.)

18852 COMPARISON OF BREIT–WIGNER AND DIPOLE DESCRIPTIONS OF STRUCTURE IN THE f^0-MASS REGION. Scarrott, S. M.; Kemp, D. (Univ. of Durham, Eng.). Lett. Nuovo Cim.; 3: No. 7, 271-4(12 Feb 1972).

Evidence was previously presented for structure in the f^0-meson mass region in a $\pi^+d \rightarrow \rho_s\rho\pi^+\pi^-$ bubble chamber experiment at 11.7 GeV/c. A maximum likelihood method is used to fit a single Breit–Wigner function, a dipole function, and a combination of these to the experimental mass spectrum in the f^0 region and also to a number of Monte Carlo generated spectra corresponding to either a single Breit–Wigner distribution or to a dipole distribution. It is concluded that the structure observed is most likely to be due to a statistical fluctuation. (L.B.S.)

18853 REACTIONS $K^-p \rightarrow K^{*\bar{0}}(890)N$ AND $K^-p \rightarrow K^{*\bar{0}}(1420)N$ AT 14.3 GeV/c. Chaurand, B. (Ecole Polytechnique, Paris); Drevillon, B.; Labrosse, G.; (and others). Phys. Lett.; 38B: No. 4, 253-6(21 Feb 1972).

Preliminary results are presented on K*(890) and K*(1420) production in three-body final states of 14.3 GeV/c K^-p interactions. For $K^{*\bar{0}}(890)$ production, the total and differential cross sections and the density matrix elements are determined. The K^{*-} reaction is found to be dominated by natural parity exchange and the charge exchange reaction by unnatural parity exchange. The total cross sections are given for $K^{*\bar{0}}(1420)$ production. (auth)

18854 STUDY OF INCLUSIVE REACTIONS OF $\pi^+ + p \rightarrow X +$ ANYTHING ($X = \pi^+, \pi^-, K_S^0$) AT 6 AND 22 GeV/c. Crennell, David J.; Gordon, Howard A.; Ioffredo, Michael L.; Lai, Kwan-wu (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 28: No. 10, 643-6(6 Mar 1972).

New single-particle spectra and average charged multiplicity distributions for the inclusive reactions $\pi^+ + p \rightarrow X +$ anything at 6 and 22 GeV/c are presented. Limiting behavior for exotic reactions ($X = \pi^-, K_S^0$) and nonlimiting behavior for the nonexotic reaction ($X = \pi^+$) are observed. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 17467.

General

Refer also to abstracts 18802 and 19068.

18855 (ANL/HEP–7107) TALKS PRESENTED AT THE SYMPOSIUM ON HIGH ENERGY INTERACTIONS AND MULTIPARTICLE PRODUCTION. (Argonne National Lab., Ill.). 19 Nov 1970. 154p. Dep. NTIS.

The conference included four papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 18819, 18829, 18856, and 18857.

18856 (ANL/HEP–7107, pp 35-92) MULTIPERIPHERAL MODELS. Pignotti, Alberto (Washington Univ., Seattle). 19 Nov 1970.

From Talks presented at the symposium on high energy interactions and multiparticle production.

The general properties of the multiperipheral model are discussed. Peripheralism, multiperipheralism, duality, the bare bones model, topological cross sections, the ABFST model, integral equation, and multiperipheral bootstrap are discussed. Also covered are shadow scattering, single-particle distributions, the external diagram, favored and unfavored fragmentation, the internal diagram, Regge behavior, momentum limitation, angular distributions, beyond the single-particle distributions, and the can of worms. (J.F.P.)

18857 (ANL/HEP–7107, pp 144-54) MAVERICK MODELS. Ross, Marc (Michigan Univ., Ann Arbor). 19 Nov 1970.

From Talks presented at the symposium on high energy interactions and multiparticle production.

Evidence is given that diffraction dissociation is not dominant at 30 GeV/c and that high multiplicity events are not peripheral. (J.F.P.)

18858 (CERN–72-1) SHOULD UNITARITY BE TESTED EXPERIMENTALLY. Eberhard, P. (European Organization for Nuclear Research, Geneva (Switzerland)). 13 Jan 1972. 24p. Dep. NTIS (U. S. Sales Only).

In order to make a clear distinction between the consequences of unitarity that are not directly required by probability conservation and the others, a theory is constructed where some properties derived from the unitarity principle are violated but unitarity is conserved. For this purpose a very small change is made in the axioms of quantum theory. The applications discussed include the optical theorem for the scattering of two particles, $\Xi \rightarrow \Lambda + \pi$ decays, decays of K^0, and hyperon and K^- production in a K^0 beam and K^+ production in a $\overline{K}^0$ beam. (J.F.P.)

18859 CONFORMAL-INVARIANT PHASE SHIFT ANALYSIS. Castell, L. (Max-Planck-Institut fuer Physik und Astrophysik); Ringhofer, K. Lect. Theor. Phys.; 13: 269-80(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The conformal-invariant S-matrix is defined for elastic scattering of spin-zero particles with mass m = 0 and with mass m > 0. For the S-matrix a partial wave expansion is given. The comparison with the usual scattering phases ($e^{2i\delta l(s)} - 1$) allows one to make definite predictions about their s dependence and certain angular momentum correlations. (auth)

18860 MASS ZERO PARTICLES IN DE SITTER SPACE. Boerner, Gerhard (Max-Planck-Institut fuer Physik und Astrophysik, Munich, Ger.). Lect. Theor. Phys.; 13: 409-19(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The discussion of mass-0 particles in de Sitter space covers spin-0 particles, photons, and spin-½ fields. (J.F.P.)

18861 RELATIVISTIC THREE-PARTICLE EQUATIONS. van der Merwe, P. du T. (Atomic Energy Board, Pretoria). Phys. Rev., D; 5: No. 2, 353-7(15 Jan 1972).

A functional derivation is presented of relativistic three-particle equations in configuration space. The equations are formulated in terms of two-particle attributes and the inhomogeneous terms are factorized in terms of the two-particle T matrix. The equations are furthermore exhibited in a practicable form in which the kernel is connected and the inhomogeneous terms contain multiple-scattering contributions. (auth)

18862 INCLUSIVE CROSS-SECTIONS AND DISCONTINUITIES. Polkinghorne, J. C. (Cambridge Univ., Eng.). Nuovo Cim.; 7A: No. 3, 555-66(1 Feb 1972).

The effect of physical-region Landau curves on the inclusive differential cross section is investigated for a typical class of

curves. It is concluded that the differential cross section is a total discontinuity in the missing mass variable M^2 of an amplitude evaluated on an unphysical sheet. There is a point of non-analyticity at each new singularity. (auth)

18863 ASYMPTOTIC BEHAVIOUR OF TWO PARTICLE SPECTRA. Parry, G. W. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B37: No. 2, 477-92(1972).

The multi-Regge model is used to calculate some interesting kinematic limits of the process a + b → c + d + anything. Following Mueller the standard deviation of the distribution of produced particles is calculated. (auth)

18864 RELATING THE CLASSICAL AND QUANTAL THEORIES OF ANGULAR MOMENTUM AND SPIN. Norcliffe, A. (Univ. of Stirling, Scotland). J. Phys., A (London); 5: No. 2, 231-40(Feb 1972).

The classical and quantal theories of angular momentum and spin are related using the spherical top as a model. The quantum mechanical spectral operator kernel of the spherical top is evaluated and expressed exactly as a sum over classical paths of terms containing the classical action. A relation between corresponding values of the classical and quantal angular momentum is obtained which holds for all values of the angular momentum quantum number j. (auth)

18865 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 26, 1971. Frankfurt am Main; Zentralstelle fuer Atomkern-energie-Dokumentation (1971). 93p.

18866 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 1-2, 1972. Frankfurt am Main; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 94p.

18867 UNITARITY AND THE INTERACTION OF MASSLESS PARTICLES. Prokhorov, L. V. (Leningrad State Univ.). Teor. Mat. Fiz.; 10: No. 2, 264-70(Feb 1972). (In Russian).

The restrictions are studied which the unitarity condition imposes on the effective interaction of massless particles. It is shown that only the interactions of the nonrenormalizable type are acceptable. (auth)

18868 CONDITIONS OF THE SOLUTION EXISTENCE FOR THE EQUATIONS OF THE TYPE OF THE DIFFERENTIAL METHOD EQUATIONS. Chermalykh, G. N. (Inst. of Casting Problems, Moscow). Teor. Mat. Fiz.; 10: No. 2, 215-22(Feb 1972). (In Russian).

The equations of the type of the differential method equations are examined as linear singular integral equations with respect to the inelasticity coefficients. The real parts of the phase shifts are supposed to be known functions. For any finite system the existence of the unique (except for the polynomial CDD-ambiguity) solution is proved under rather weak restrictions on the dependence of the "crossing" matrix elements $\beta\mu'(\omega,\omega')$ in ω, ω' (where l, l' are angular momenta and ω, ω' the c.m. energies of the direct and crossed channels respectively). It is also shown that the requirement of the existence of the solution (in the class of continuous bounded functions) of the linear integral equation which is equivalent to the infinite systems leads to the restriction $\beta\mu'(\omega, \omega') \to 0$ as $l, l' \to \infty$; $\omega, \omega' \in [\omega_1, \infty]$ and ω_1 being the inelastic threshold, and also to the following characteristic behavior of the strong interaction partial-wave amplitude: $T_l(\omega)_{l\to\infty} 0$ ($\omega \in [\omega_1, \infty]$) usually deduced from the axiomatic s ⊗ t-analyticity. The models with the short-wave repulsion as well as the inelastic effects in the different method models are discussed. (auth)

Electromagnetic

Refer also to abstracts 18810, 18811, 19046, 19102, 19120, and 19125.

18869 (COO-3067(2)-1) SCALING PROPERTIES AND THE BOUND-STATE NATURE OF THE PHYSICAL NUCLEON. Drell, S. D. (Stanford Linear Accelerator Center, Calif.); Lee, T. D. (Columbia Univ., New York). [1971]. 87p. (SLAC-PUB-997). Dep. NTIS.

The scaling property in deep inelastic electron scattering is established by regarding the physical nucleon as a bound state of a bare nucleon and a bare meson (or a few bare mesons). This bound-state formulation provides a fully relativistic generalization of the "parton" model that is no longer restricted to infinite momentum frames. It also connects the scaling property in inelastic processes with the rapid decrease of the electromagnetic form factors in elastic scattering. Rigorous statements are derived for specific bound-state solutions of the Bethe–Salpeter equation with the ladder approximation. An Adler sum rule is derived and crossing properties are discussed. A general phenomenological approach is developed which is relativistically covariant and gauge invariant, and it allows one to correlate directly the observed structure functions and form factors with the appropriate bound-state wave function. By assuming all constituents in the bound state to be of masses ≲1 GeV, the model gives a qualitative understanding as to why the scaling property is experimentally observed at relatively moderate energies. (auth)

18870 (DESY-71/63) SEPARATION OF RESONANT AND NONRESONANT CONTRIBUTIONS TO INELASTIC ELECTRON–NEUTRON CROSS SECTIONS AND ISOTENSOR CONTRIBUTIONS TO THE ELECTROMAGNETIC CURRENT IN THE REGION OF THE Δ(1236) RESONANCE. Bleckwenn, J.; Moritz, J.; Schmidt, K. H.; Wegener, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 12p. Dep. NTIS (U.S. Sales Only).

The cross section for electroproduction on protons and neutrons was investigated by momentum analysis of scattered electrons. For momentum transfers $0.1\ (\mathrm{GeV/c})^2 < q^2 < 0.5\ (\mathrm{GeV/c})^2$ and invariant masses $W < 1.4$ GeV of the final hadronic state the measured cross section was split up into a resonant and a nonresonant contribution. The transition form factor $G_M^*(q^2)$ of the γnΔ-vertex is derived from the resonant cross section. The equality of the resonant respective the nonresonant part of the excitation cross section on neutrons and protons permits one to derive upper limits for the isotensor and isoscalar current to electroproduction processes. (auth)

18871 (ITF-71-26-P) METHOD OF DISPLACEMENTS AND COLLECTIVE VARIABLES. Yukhnovskii, I. R. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 82p. (In Russian). Dep. NTIS (U. S. Sales Only).

The statistical sum and statistical operator $\exp-\beta H$ of the system of interacting charged particles is considered. The method of displacements and collective variables (DCV) proposed for calculation Z is based on the following two transformations. Transformation of displacements as a result of which the potential function equal to the sum of many particle interactions between packets appears. The interaction between packets of particles has no singularities at small distances. The transition from Decarte coordinates to the collective variables with the help of the Zubarev transition strict Jacobian; in this case the necessity in artificial restrictions on the wave vector spectrum does not arise. As a result of integration in the space of collective variables with this Jacobian the screening appears automatically which removes divergences at large distances. The statistical sum takes the exponent form of the sum of group integrals containing the screening potentials of interaction between the wave packets of particles. (auth)

18872 (ITF-71-81-E) PHOTOPRODUCTION VECTOR AND AXIAL-VECTOR RESONANCES IN BROKEN NONLINEAR CHIRAL SU(3) x SU(3) DYNAMICS. Egorov, A. V.; Kelemen, V. I.; Sabo, V. Ya.; Sosnivker, V. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 7p. Dep. NTIS (U. S. Sales Only).

Within the frameworks of the broken nonlinear chiral SU (3) × SU (3) dynamics of hadrons the prediction of photoproductions of all vector and all axial-vector resonances by baryons N and Σ in near threshold region are calculated. It is possible to apraise all the predictions as in satisfactory agreement with the available experimental data, it is known that in a number of cases the dynamical predictions agree more exactly with the experiment than those of the dispersion approach. (auth)

18873 (JINR-E2-6160) TWO-PION PRODUCTION IN THE INTERACTION OF VIRTUAL PHOTONS. Isaev, P. S.; Khleskov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 17p. Dep. NTIS (U. S. Sales Only).

The reaction $\gamma + \gamma \to \pi + \pi$ was studied by the use of dispersion relations for virtual photons at low energies. Cross sections of the process $\gamma + \gamma \to \pi + \pi$ were calculated both for transverse and longitudinal photons. Cross sections with $\pi\pi(T = 0)$, $\pi^+\pi^-$ final states have the resonant enhancements due to the σ meson. Cross sections of the reaction $e + e \to e + e + \pi + \pi$ were calculated. (auth)

18874 (LA-tr-72-3) MONTE CARLO CALCULATIONS OF ELECTRON-PHOTON CASCADE SHOWERS IN LEAD. Captions of Tables Only. (Akademiya Nauk SSSR, [Leningrad]. Fiziko-Tekhnicheskii Institut). Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from report FTI-285. 49p. Dep. NTIS.

Tables of data on charged particle average number, angular

distributions, and probabilities for electron–photon cascade showers in lead are presented. (J.F.P.)

18875 CONSTANT-CROSSED-FIELD ACCELERATION, A MECHANISM FOR THE GENERATION OF COSMIC RAYS BY STRONG LOW-FREQUENCY ELECTROMAGNETIC WAVES. Grewing, M. (Univ., Bonn); Heintzmann, H. Phys. Rev. Lett.; 28: No. 6, 381-4(7 Feb 1972).

Magnetized stars contracting to neutron star dimensions or collapsing to a black hole will emit large quantities of electromagnetic radiation. It is shown that under favorable circumstances cosmic rays can be generated with energies in excess of 10^{21} eV. (auth)

18876 REACTION $\gamma p \to \eta p$ AND THE DIP MECHANISM IN PHOTOPRODUCTION. Rakov, Yu. A.; Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 9, 362-4(5 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 9, 526-9(5 Nov 1971).

It is shown that when it is assumed that the trajectories of the ω and ρ mesons become complex at $t < 0$ for the photoproduction of η mesons, it is possible to eliminate a previous contradiction and to reconcile the presence of the nonsense factor α in the residue of the poles with the absence of a dip in the cross sections at $t = -0.55$. (J.F.P.)

18877 TOTAL CROSS SECTIONS FOR THE REACTIONS $2\gamma \to 3\pi$ AND $e^+e^- \to e^+e^-3\pi$. Pratap, M.; Smith, J.; Uy, Z. E. S. (State Univ. of New York, Stony Brook). Phys. Rev., D; 5: No. 1, 269-70(1 Jan 1972).

Using the model-independent $2\gamma \to 3\pi$ amplitude recently given by Adler, Lee, Treiman, and Zee, the total cross section for $2\gamma \to \pi^+\pi^-\pi^0$, and the total cross section for $e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$ in the Weizsäcker–Williams approximation are calculated. Some comments are also made on the cross section for $\mu^+\mu^- \to \pi^+\pi^-\pi^0$ and its relevance to the decay $K_L^0 \to \mu^+\mu^-$. (auth)

18878 PHOTOREACTIONS ON NUCLEI AND VECTOR-MESON-DOMINANCE BREAKING. Bc :hmann, G. V. (McGill Univ., Montreal). Phys. Rev., D; 5: .o. 1, 266-8(1 Jan 1972).

Within a coupled-channel optical model, calculations of photon-nucleus total cross sections and π^+ photoproduction on nuclei at high energy are presented and compared with experimental data. The question of the validity of vector-meson dominance (VMD) is discussed. It is found that the fair agreement between theory and experiment in a recent paper by Bochmann, Margolis, and Tang can be greatly improved if one uses experimental two-body amplitudes and allows for deviations from the VMD model for the production reactions $\gamma p \to \rho^0 p$ and $\gamma p \to \pi^+ n$. (auth)

18879 COMMENTS ON SINGLE-π^+ ELECTROPRODUCTION AND THE VECTOR-MESON-DOMINANCE MODEL. Cho, C. F. (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 1, 260-3(1 Jan 1972).

The problem of mass extrapolation in the vector-meson-dominance predictions of single-π^+ electroproduction is examined within the framework of the electric Born model. (auth)

18880 POSSIBLE EFFECTS OF THE LEE–WICK HEAVY PHOTON IN e^-e^+ ELASTIC SCATTERING. Resnick, L.; Sundaresan, M. K. (Carleton Univ., Ottawa). Phys. Rev., D; 5: No. 1, 264-5(1 Jan 1972).

The helicity amplitudes for high-energy e^-e^+ elastic scattering are examined to lowest order in the fine-structure constant and the lepton mass when the propagator is modified according to the hypothesis of Lee and Wick. It is suggested that the effects can be a sensitive test for the existence of the heavy photon, and that to this end the cross section for helicity states of the outgoing leptons at backward angles should be measured. (auth)

18881 MULTIPERIPHERAL MODELS AND DEEP-INELASTIC SCATTERING. Nussinov, S. (State Univ. of New York, Stony Brook); Rangwala, A. Phys. Rev., D; 5: No. 1, 220-6 (1 Jan 1972).

A simple multiperipheral approach based on the assumed cutoff of internal momentum transfer is shown to yield all predictions of more sophisticated Bethe-Salpeter and field-theoretic approaches. Scaling arises simply as a requirement for the scaling down of the initial energy when the real or virtual external masses considerably exceed the assumed small unversal cutoff of internal momenta. (auth)

18882 PARTON MODEL FOR THE ELECTROPRODUCTION OF SINGLE HADRONS WITH HIGHLY VIRTUAL PHOTONS. Roy, Probir (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 5: No. 1, 227-46(1 Jan 1972).

The contrasting dynamical roles played by the "wee" and the "nonwee" partons in the process $ep \to e'AB$ (A, B being hadrons) when the negative squared mass Q^2 of the virtual photon becomes large are studied. Two relevant asymptotic limits are pointed out and are shown to be controlled by the two different parton mechanisms which are possible. In each case, one of the two final hadrons is forced to emerge predominantly in the direction of the virtual photon in the laboratory. This imposes testable kinematic restrictions for either limit. Moreover, the behavior of the structure function w_2 in these two limits is related to the square of the asymptotic electromagnetic form factor times unknown functions of the scaling variables. (auth)

18883 PHOTOPRODUCTION OF SINGLE SPIN-ONE W BOSONS AT HIGH ENERGIES. Fearing, Harold W. (Los Alamos Scientific Lab., N. Mex.); Pratap, Mahendra; Smith, Jack. Phys. Rev., D; 5: No. 1, 177-88(1 Jan 1972).

The production of single W bosons by high-energy photons via the reaction $\gamma + p \to n + W$ is analyzed using a model previously applied to the muon reaction $\mu + p \to \mu + n + W$. Results are given for total cross sections and angular and energy distributions for a variety of W-boson masses. (auth)

18884 $\pi^+\Delta$ ELECTROPRODUCTION IN THE ELECTRIC BORN MODEL. Berends, F. A. (Harvard Univ., Cambridge, Mass. Massachusetts Inst. of Tech., Cambridge); Gastmans, R. Phys. Rev., D; 5: No. 1, 204-15(1 Jan 1972).

The electric Born model for $\pi^+\Delta$ photoproduction is extended to electroproduction, allowing for different electric form factors for the participating particles. A comparison with recent small-angle $\pi^-\Delta^{++}$ and $\pi^+\Delta^0$ electroproduction data is made. The longitudinal cross section is larger than the transverse cross section, although its predominance is less pronounced than in π^+n electroproduction. The model is also used to describe the reaction $\pi^+p \to \rho^0\Delta^{++}$. (auth)

18885 SINGLE π^+ ELECTROPRODUCTION AT $w \approx 2$ GeV AND THE PION FORM FACTOR. Devenish, R. C. E.; Lyth, D. H. (Univ. of Lancaster, Eng.). Phys. Rev., D; 5: No. 1, 47-59(1 Jan 1972).

Recently published data on $ep \to en\pi^+$ near $w = 2$ GeV and $0.0 < |k^2| < 1.0$ GeV^2 are investigated using (i) the model-independent Chew-Low extrapolation technique and (ii) fixed-t dispersion relations. The data are not accurate enough to allow the Chew–Low fit to give an unambiguous determination of F_π. Using fixed-t dispersion relations $F_\pi(k^2) = 1/(1 - k^2/0.5\ \text{GeV}^2)$ is obtained. The effect of resonances other than the P_{33} is small. (auth)

18886 INELASTIC PHOTOPRODUCTION OF SPIN-ONE W^+ BOSONS IN A QUARK–PARTON MODEL. Mikaelian, K. O. (State Univ. of New York, Stony Brook). Phys. Rev., D; 5: No. 1, 70-5 (1 Jan 1972).

The quark-parton model is applied to the inelastic photoproduction of single W^+ bosons, with any number of hadrons present in the final state. The total cross section and the energy and angular distributions of the bosons are computed. The energy distribution is found to be peaked near the high-energy region, and a very sharp forward peak is found in the angular distribution. Experimental difficulties will make it hard to treat this process as a test of the model which, however, can be used to obtain an estimate of the various cross sections. (auth)

18887 FINITE PROTON–NEUTRON MASS DIFFERENCE AND SCALE INVARIANCE. Moffat, J. W.; Wright, A. C. D. (Univ. of Toronto). Phys. Rev., D; 5: No. 1, 75-9(1 Jan 1972).

A representation of the forward Compton amplitude in which the A_2 meson breaks scale invariance is shown to be consistent with existing data for the difference between the protons and neutron structure functions $\nu W_2^p - \nu W_2^n$, while ensuring a finite proton-neutron mass difference ΔM. The conjecture that $W_1 \equiv W_1 + (\nu^2/q^2)W_2 \to 0$ as $\nu \to \infty$ for fixed q^2 leads to an expression for ΔM in terms of measurable quantities. (auth)

18888 FORM FACTORS FOR DOMINANT INELASTIC e^+-e^+ COLLISIONS AT HIGH ENERGIES. Starke, Charles L. (State Univ. of New York, Stony Brook). Phys. Rev., D; 5: No. 1, 79-86(1 Jan 1972).

Forms for the cross section of e-e two-photon processes, $e + e \to e + e +$ hadrons, analogous to the W_1, W_2 form factors in e-p inelastic collisions are studied and presented. In general, the cross sections are a function of ten form factors. Two do not contribute if time-reversal invariance holds. At very high energies, with no polarization measurements or with real photons, the cross sections reduce to functions of fewer form factors. (auth)

18889 ENERGY STRAGGLING AND RADIATION REACTION FOR MAGNETIC BREMSSTRAHLUNG. Shen, C. S.; White, D.

(Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 28: No. 7, 455-9(14 Feb 1972).

When the average energy of the photon emitted by synchrotron radiation becomes appreciable compared to the energy of the particle, the particle will undergo straggling in its energy loss, which in turn broadens the radiation spectrum. The energy distributions of particles and the emitted photons are calculated using the method of quantum electrodynamics. The results are presented together with effects due to classical radiation reaction for experimental test. The significance of energy straggling in astrophysics is discussed briefly. (auth)

18890 NEW EQUATION OF MOTION FOR CLASSICAL CHARGED PARTICLES. Mo, Tse Chin; Papas, C. H. (California Inst. of Tech., Pasadena). Phys. Rev., D; 4: No. 12, 3566-71 (15 Dec 1971).

With the intuitive new ideas that (1) in classical electrodynamics, radiation reaction should be expressible by the external field and the charge's kinematics, (2) a charge experiences, in addition to the Lorentz forces, another "small" external force $e_1 F^{\mu\lambda} u_\lambda$ proportional to its acceleration, and (3) inertia plus radiation is balanced by these two external forces, a new equation of motion is proposed where mass conservation requires $e_1 = 2e^3/3m$. (The particle's spin is not considered in this work.) This equation for a classical charge is free from all the well-known difficulties of the Lorentz–Dirac equation. It conserves energy and momentum in a modified form in which the energy-momentum tensor contains a part $t^{\mu\nu}(x)$ made of a new field-charge interaction $\phi^\mu(x)$, in addition to the conventional "local" part made of $F^{\mu\nu}_{ret}(x)$ and $F^{\mu\nu}_{ext}(x)$ only, and therefore it no longer satisfies the conventional "local" conservation laws. It predicts correct radiation damping, as demonstrated by applying it to various cases of basic physical importance. Also, it implies that a massless particle follows a null geodesic and cannot interact with the electromagnetic field whether it be charged or not; this implication may add a new degree of freedom to the charge-conservation law. (auth)

18891 MOTION OF SPIN-1 PARTICLES IN A HOMOGENEOUS MAGNETIC FIELD: MULTISPINOR FORMALISM. Tsai, Wu-yang (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 4: No. 12, 3652-7(15 Dec 1971).

A general method of calculation within the multispinor formalism is proposed. It is then used to calculate the eigenvalues of the theory of particles with any spin moving in a homogeneous magnetic field, without explicitly solving the equation of motion. The spin-1 theory with anomalous-magnetic-moment couplings is examined specifically. The results differ from those obtained by Tsai and Yildiz using the vector theory, and from those obtained by Goldman and Tsai and by Krase, Lu, and Good using the six-component theory. It is found that the discrepancies are due to the fact that different nonminimal couplings are in fact added to various theories. However, when only minimal couplings are considered, all three theories predict the same eigenvalues. In this case, the square of an eigenvalue is a perfect square and is positive definite. In the case where nonminimal couplings are added, the square of an eigenvalue can become negative in all three theories, i.e., the energy eigenvalues can become pure imaginary. Possible physical interpretations of the results are discussed. (auth)

18892 MOTION OF CHARGED PARTICLES IN A HOMOGENEOUS MAGNETIC FIELD. II. Goldman, Terrence; Tsai, Wu-yang (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 4: No. 12, 3648-51(15 Dec 1971).

The general method proposed by Tsai and Yildiz to obtain the eigenvalues of any spin theory is used to solve the eigenvalues of the 6-component theory of Shay and Good. This calculation method clearly demonstrates how the vector theory of Proca and Kemmer differs from the 6-component theory. An extra term which contributes to the $S_3 = 0$ case only is obtained in the 6-component theory, which explains the difference in the results obtained from the two different theories. With the result obtained, it is observed that the 6-component theory is consistent only when there is no anomalous-magnetic-moment coupling. Possible interpretations of the inconsistency are also discussed. (auth)

18893 MOTION OF CHARGED PARTICLES IN A HOMOGENEOUS MAGNETIC FIELD. Tsai, Wu-yang; Yildiz, Asim (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 4: No. 12 3643-8(15 Dec 1971).

A general and simple method is presented to calculate the eigenvalues of the eigenequation for the theory of a particle with any spin with anomalous-magnetic-moment coupling moving in a homogeneous magnetic field. The eigenvalues of the spin-$\frac{1}{2}$ and spin-1 systems are obtained specifically. This method of approach does not require an explicit solution of the eigenfunction equation. Different spin-1 theories (vector theory, multispinor theory, and 6-component theory) are discussed, and in the case of no anomalous-magnetic-moment coupling terms, all these theories predict the same eigenvalues. Furthermore, by requiring that the energy eigenvalues be positive definite, it is shown that the vector spin-1 theory is consistent only when no anomalous-magnetic-moment coupling terms exist. (auth)

18894 SELF-CONSISTENT DISPERSION-THEORETIC ELECTROMAGNETIC SCATTERING AMPLITUDES. McEnnan, James (Univ. of Florida, Gainesville). Phys. Rev., D; 4: No. 12, 3684-93(15 Dec 1971).

A procedure for calculating self-consistent electromagnetic scattering amplitudes when there are bound states, applied in a previous paper to the electron-positron system, is extended to include spin-0-spin-0 and spin-0-spin-$\frac{1}{2}$ elastic scattering. The second-order amplitudes which results have the correct double-spectral functions and are cutoff-independent, analytic, and crossing-symmetric. The Regge trajectory functions which are required by self-consistency imply the usual Coulomb bound-state spectrum with reduced mass and recoil corrections, and the appropriate Regge asymptotic behavior. The correspondence between the amplitudes obtained by this procedure and by other means is discussed briefly. (auth)

18895 CURRENT CONSERVATION AND DOUBLE-SPECTRAL REPRESENTATIONS FOR SCATTERING OF VECTOR PARTICLES. Feigenbaum, M. (Cornell Univ., Ithaca, N. Y.); Low, F. E. Phys. Rev., D; 4: No. 12, 3738-55(15 Dec 1971).

The spectral representation of the amplitude for photon scattering by hypothetical scalar particles is calculated in a simple perturbative model. The gauge invariance of the theory eliminates all single-spectral functions; only unsubtracted double-spectral representations persist. Although this conclusion may be a consequence of the superrenormalizability of the model, it is conjectured that it is a general result. In order to carry out this calculation, spectral representations are also constructed for certain Feynman diagrams for spinning particles. (auth)

18896 ELECTRODYNAMICS AS PROPERTIES OF DE SITTER MOMENTUM SPACE. Dalton, B. J. (Florida State Univ., Tallahassee). Lect. Theor. Phys.; 13: 431-8(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The possibility is considered of describing an elementary electromagnetic system such as a photon or an electron as a geometry. The particle and field entities are related to pure geometric quantities such as group generators of motion. The particle is viewed as a geometry itself which is independent of the background space. (J.F.P.)

18897 MAGNETIC SPIN MONOPOLE FROM THE YANG–MILLS FIELD. Joseph, A. (Tel-Aviv Univ., Israel). Phys. Rev., D; 5: No. 2, 313-20(15 Jan 1972).

A generalization of the magnetic monopole was derived in the context of the Yang–Mills field. This is achieved through the observation that the quantization of the ordinary magnetic monopole derives from closure of the angular momentum and magnetic field components on the Lie algebra of the Euclidean group E(3) and the fact that the Yang–Mills field is the generalization of the Maxwell field obtained by replacing the ordinary derivative by a covariant derivative. This leads to defining equations for the generalized monopole which are explicitly solved for the case when SU(2) is the gauge group of the field. The resulting system, referred to as the spin monopole, is investigated in some detail. (auth)

18898 RADIATIVE CORRECTIONS FOR ELECTRON SCATTERING IN AN EXTERNAL FIELD: A NEW METHOD OF CALCULATION. DeRaad, Lester L. Jr. (Univ. of California, Los Angeles); Ivanetich, Richard J.; Milton, Kimball A.; Tsai, Wu-yang. Phys. Rev., D; 5: No. 2, 358-76(15 Jan 1972).

The lowest-order radiative corrections for electron scattering in an external electromagnetic field are considered, using Schwinger's source theory. Spectral forms are employed, and the range of soft photons is invariantly specified by the final-state mass resolution (δM; $\delta M \ll$ m = electron mass). The differential cross section is dealt with directly, and elastic and inelastic contributions are not separated, thereby avoiding some of the usual infrared divergences. The resulting differential cross section appears as a factor $(1 - \delta)$ multiplying the lowest-order (Born) differential cross section plus a contribution referring to the magnetic form factor; δ is the sum of the following contributions: vacuum polarization, propagator modification, double scat-

tering, and a linear term without magnetic part. Also presented is a brief review of certain aspects of source theory. (auth)

18899 BOUNDARY DISPERSION RELATIONS. Hite, G. E.; Jacob, R. (Univ., Karlsruhe, Ger.). Phys. Rev., D; 5: No. 2, 422-7(15 Jan 1972).

A dispersion relation is derived for direct-channel reactions of the type $a + b \rightarrow c + d$ with $m_b = m_d$, e.g., $\gamma N \rightarrow \pi N$, which involves contributions from both forward and backward scattering of the direct channel and backward scattering of the crossed channel but no contribution from unphysical regions of the direct channel. In particular, the integral involving the direct-channel contribution is evaluated along the boundary of the physical region. The result, in the case of elastic scattering, i.e., $m_a = m_c$, reduces to the familiar backward dispersion relation. (auth)

18900 BJORKEN SCALING FOR INCLUSIVE AND QUASI-INCLUSIVE PROCESSES IN THE DUAL-RESONANCE MODEL. Chaichian, M. (Durham Univ., Eng.). Phys. Rev., D; 5: No. 2, 427-35(15 Jan 1972).

From a dual-resonance model with currents included through the minimal gauge interaction, the deep-inelastic electron scattering is considered. It gives the Bjorken scaling for νW_2 while W_1 vanishes, a property which is common among the models where the current is coupled to bosons. Scaling occurs because of the existence of a current-algebra fixed pole. Deep-inelastic electron scattering with one detected final-state particle is also considered which, following Mueller, is connected with the discontinuity of a six-point amplitude. In a special kinematic region, three out of four structure functions scale because of a fixed pole, while outside this region the fixed pole cannot be responsible for scaling anymore. Then a speculation of Pomeranchukon assignment does show the scaling. Inelastic Compton scattering is also considered which, in the parton model of Bjorken and Paschos, scales and is proportional to νW_2. This property is satisfied in the present model. Electron-positron annihilation into hadrons is considered without renormalization whose cross section falls off as $s^{-\frac{1}{3}}$. It is suggested that a proper dual renormalization for the self-mass diagram of the photon may change this result. (auth)

18901 ANALYTICITY IN THE FORWARD TUBE, COMPLEX SCALING, AND NEW SUM RULES FOR VIRTUAL COMPTON AMPLITUDES. Khuri, N. N. (Rockefeller Univ., New York). Contract AT(30-1)-4204. Phys. Rev., D; 5: No. 2, 462-74(15 Jan 1972).

The forward virtual Compton amplitude is studied as an analytic function of two complex variables. A method is developed for deriving sum rules that follow from analyticity in two variables where the domain of analyticity is the forward tube. Using this method, new sum rules are derived. These sum rules follow from analyticity in the tube and "complex" scaling. They relate a double integral over the inelastic form factor $W_2(\nu,q^2)$ to an integral over the scaling function $F_2(\omega)$. The sum rules provide a tool for directly testing whether scaling occurs when $|q^2| \rightarrow \infty$ in complex directions inside the tube domain, and whether this scaling starts at relatively low values of $|q_2|$ as in the real case. The possibility of finding more restrictive sum rules by enlarging the domain of analyticity is also briefly explored and a mathematical but unphysical example is given. (auth)

18902 DRELL–HEARN SUM RULE FROM EQUAL-TIME COMMUTATORS. Pradhan, T.; Khare, A. V. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., D; 5: No. 2, 496-7(15 Jan 1972).

It is shown that the Drell–Hearn sum rule can be obtained from the equal-time commutator $[D^+(t), D^-(t)] = 0$, where $D^{\pm}(t) = \int d^3x\, [(x_1 \pm ix_2)/\sqrt{2}]\, \rho(x)$, $\rho(x)$ being the electric charge density. (auth)

18903 PARTON MODEL OF ELECTROMAGNETIC FORM FACTORS OF HADRONS. Grisaru, M. T.; Visinescu, M. M. (Cambridge Univ., Eng.). Nuovo Cim.; 7A: No. 2, 417-34(21 Jan 1972).

A model for hadronic electromagnetic form factors is considered based on the idea that the photon couples directly to a spin-½ parton which interacts with hadrons. The assumptions that the parton mass is large and that hadron-parton amplitudes are the same for real or virtual partons allow the form factors to be expressed in terms of asymptotic (Regge) hadron-parton amplitudes. Using residue factorization and some simple assumptions about parton-Reggeon couplings pion and nucleon isovector electromagnetic form factors are obtained which depend mainly on their couplings to the ρ trajectory. Values for the mean-square radii are computed which are in quite good agreement with experimental ones. (auth)

18904 INELASTIC STRENGTH FUNCTION FROM THE FRAGMENTATION POINT OF VIEW. Benecke, J. (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Jacob, M. Nuovo Cim.; 7A: No. 2, 311-20(21 Jan 1972).

The famous scaling property of deep inelastic electron scattering is rephrased in the framework of the Feynman scaling property, as obtained from limiting fragmentation. The statistical fragmentation model is then used to study the behavior of the strength function W_2 as the momentum transfer tends to infinity. Although the Bjorken limit vanishes in this model, the Feynman scaling limit is readily satisfied at fixed momentum transfer. (auth)

18905 EXACT SOLUTIONS OF AN n-DIMENSIONAL ANISOTROPIC OSCILLATOR IN A UNIFORM MAGNETIC FIELD. Bergmann, E. E.; Holz, A. (Lehigh Univ., Bethlehem, Pa.). Nuovo Cim.; 7B: No. 2, 265-76(11 Feb 1972).

A set of exact solutions is found from the positive-definite Hamiltonian $H = \frac{1}{2}(pM^{-1}p + [q,Aq]_+ + qKq)$, where M and K are symmetric, real $n \times n$ matrices and where A is an arbitrary real $n \times n$ matrix. This Hamiltonian corresponds to an anisotropic harmonic oscillator in a uniform magnetic field. The method consists of solving a 2n-dimensional eigenvalue problem. The eigenvalues provide the characteristic transition frequencies and the eigenvectors are used to construct annihilation and creation operators a_j and $a_j^\dagger$. The procedure is similar to Bogolyubov transformation. These eigenvectors are also used to re-express the q and p as linear combinations of these a_j and $a_j^\dagger$. The ground-state function is found; in the appropriate gauge it is a real Gaussian function of the q. (auth)

18906 HARMONIC OSCILLATOR WITH TRANSLATIONAL DEGREES OF FREEDOM IN A MAGNETIC FIELD. Holz, A.; Bergmann, E. E. (Lehigh Univ., Bethlehem, Pa.). Nuovo Cim.; 7B: No. 2, 277-83(11 Feb 1972).

A procedure to find exact solutions for a general m-dimensional anisotropic harmonic oscillator in a uniform, but otherwise arbitrary magnetic field in an n-dimensional space (of dimension larger than m) is described. Exact solutions of Schrödinger's equation were previously presented for the above problem when the dimension of the oscillator potential coincided with the dimension of the space (i.e., no translational degrees of freedom). Consequently only the procedure for finding a Landau-like gauge so that the Hamiltonian may be separated into two parts is detailed. One part contains all explicit reference to those linear momenta which are constants of the motion. The other part is shown to be of the form requisite to be exactly solved by the previous methods. (auth)

18907 CLASSICAL COUNTERPART TO DOUBLE COMPTON SCATTERING. Melrose, D. B. (Australian National Univ., Canberra). Nuovo Cim.; 7A: No. 3, 669-86(1 Feb 1972).

It is shown that the classical interaction between a charged particle and a radiation field (Thomson scattering) involves a hierarchy of processes analogous to that for photon-electron scattering (Compton scattering) in quantum electrodynamics. Statements that the double and multiple Compton effects are intrinsically quantum-mechanical processes are incorrect; it is shown that double Thomson scattering is the classical counterpart of the double Compton effect. However, it is only the inverse of double Compton scattering (two photons scattered into one photon) which has a classical counterpart; the direct process does not. Familiar examples of the interaction of three waves in nonlinear plasma theory are shown to be particular cases of double Thomson scattering. (auth)

18908 SIMPLE PHENOMENOLOGICAL DESCRIPTION OF LOW-ENERGY $\gamma\gamma \rightarrow \pi\pi$. Yndurain, F. J. (CERN, Geneva). Nuovo Cim.; 7A: No. 3, 687-94(1 Feb 1972).

A simple phenomenological parametrization, embodying corrections due to hadronic interactions for the process $\gamma\gamma \rightarrow \pi\pi$, is presented. (auth)

18909 ELECTROPRODUCTION OF NUCLEON ISOBARS IN THE QUARK MODEL. Le Yaouanc, A.; Oliver, L.; Pene, O.; Raynal, J.-C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B37: No. 2, 552-76(1972).

The electroproduction of N* resonances in the quark model has been extensively studied by Thornber, using the symmetric harmonic oscillator quark model, developed later by Faiman and Hendry. Encouraging results were obtained for small q^2, but there was a strong disagreement for $q^2 \geq 1$ GeV^2 not only for the absolute values but also for the ratio $(d\sigma/d\Omega)$ (N*)/[$(d\sigma/d\Omega)$ (elastic)]. It is shown that this disagreement is mainly due to a bad choice of the frame where the nonrelativistic transition form factors are calculated. There are physical reasons for

choosing a frame near the Briet frame. Also the quark form factor needed by the various other successes of the symmetric oscillator quark model (spectroscopy, strong and electromagnetic widths, differential photoproduction, elastic and diffractive processes) is introduced, while Thornber considered point quarks. The origin of this quark form factor, either static charge distribution or mediating particle is discussed. Without any free parameter, good results for the ratio $(d\sigma/d\Omega)$ $(N^*)/[(d\sigma/d\Omega)(\text{elastic})]$ are obtained, up to large q^2 (~3 GeV^2) for the four main bumps. However, when the contributions of all the established resonances (M < 2.2 GeV) are discussed there arise problems with the radial excitations and the $P_{13}(1870)$. Concerning the absolute magnitude, it is thought one may attribute the discrepancy between the dipole and gaussian form factors to relativistic corrections as first suggested by Licht and Pagnamenta, and Fujimura et al. (auth)

18910 THREE PION PRODUCTION IN ELECTRON COLLIDING BEAMS. Koeberle, R. (Deutsches Elektronen-Synchrotron, Hamburg). Phys. Lett.; 38B: No. 3, 169-73(7 Feb 1972).

The total cross section for the reaction $ee \rightarrow ee + 3\pi$ is calculated in a model, which includes ρ and σ mesons, the incorporates gauge invariance and the hypothesis of the partially conserved axial vector current. (auth)

18911 COLLIDING ELECTRON VERSUS COLLIDING PHOTON BEAMS. Pais, A. Comments Nucl. Particle Phys.; 5: No. 1, 26-33(Jan-Feb 1972).

A discussion is presented on the quantum electrodynamics of colliding e^+-e^- beams, several facilities for which are now in operation. Amongst matters discussed are hadronic one-quantum annihilation, the $e^+e^-/\gamma\gamma$ competition, and the large number of problems, both experimental and theoretical, that need to be better understood. (19 references) (UK)

18912 APPARENT ANOMALIES IN ETA- AND K-MESON PHOTOPRODUCTION AND STRAY BARYONIC STATES. Donnachie, A. (Univ. of Manchester, Eng. Nuclear Physics Lab., Daresbury, eng.). Lett. Nuovo Cim.; 3: No. 6, 217-22(5 Feb 1972).

It is shown that if the almost equal isoscalar photo-excitation of the stray baryonic states P_{11} and P_{13} are conjectured then the threshold anomaly in the $\gamma + p \rightarrow \eta + p$ interaction can be resolved. The anomalies in the $\gamma + p \rightarrow K^+ + \Lambda$ interaction are also studied. (J.F.P.)

18913 EXACT CALCULATIONS OF PAIR PRODUCTION AND SCREENING. Proriol, J. (Laboratoire de Physique Nucleaire, Clermont-Ferrand, France). Lett. Nuovo Cim.; 3: No. 6, 251-3(5 Feb 1972).

The effect of screening in the exact calculation of pair production is studied. A scheme is developed for the method of writing the exact equations for the radial solutions of the Dirac equation in the nuclear field for a screened atom, and of obtaining good approximate solutions of these equations. (J.F.P.)

18914 ASYMPTOTICAL PROPERTIES OF THE ELECTRON-PROTON SCATTERING AMPLITUDE AND SUM RULES FOR THE SCHWINGER TERM. Zinov'ev, G. M.; Miranskii, V. A. (Inst. of Theoretical Physics, Moscow). Teor. Mat. Fiz.; 10: No. 2, 204-8 (Feb 1972). (In Russian).

The relation is established between the asymptotical behavior of the electron-proton scattering amplitude, the Jost–Lehmann–Dyson (JLD) spectral function of the current commutator, and the sum rules for the Schwinger term. It is shown that the conditions on the JLD spectral function are less restrictive than those which lead to the "scattering invariance" property of the scattering amplitude. (auth)

18915 CONNECTION OF THE DEUTERON FORM FACTORS WITH THE PHYSICAL S-MATRIX. II. Troitskii, V. E.; Trubnikov, S. V.; Shirokov, Yu. M. (Moscow State Univ. Mathematics Inst., Moscow). Teor. Mat. Fiz.; 10: No. 2, 209-14(Feb 1972). (In Russian).

The form factors of the electromagnetic current matrix element of the neutron-proton system were expressed via the relativistic Jost matrix. The relativistic parametrization of the neutron-proton system derived previously is used. The anomalous cut contribution was evaluated exactly. The effects of the mesic currents and the inelastic n–p channels were neglected. The obtained results are necessary for the calculation of the electromagnetic form factors of the deuteron via the neutron-proton scattering matrix on the mass shell. (auth)

Weak

Refer also to abstracts 18622, 19044, and 19045.

18916 (LBL–593) GENERALIZED MECHANISM FOR μ^+ DEPOLARIZATION IN SOLUTIONS. Brewer, J. H.; Crowe, K. M.; Johnson, R. F.; Schenck, A. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 12p. (CONF-710911–12; CONF-710933–5). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

From Muon physics conference; Fort Collins, Colo. (6 Sep 1971).

The formalism developed by Ivanter and Smilga to describe the "muonium mechanism" of positive muon depolarization is adapted and extended to include situations involving more than one strongly depolarizing influence (e.g., muonium and radical). In such cases the Laplace transform method is inapplicable, and the explicit time dependence of the relevant spin systems must be solved. Calculations are shown for a plausible situation with the assumption of a transverse external magnetic field; the line of reasoning is outlined, and should be readily extendable to other cases, or to a longitudinal field. (auth)

18917 (NYO–1932(2)-203) PRODUCTION CROSS SECTIONS FOR LEE–WICK MASSIVE ELECTROMAGNETIC BOSONS AND FOR SPIN-0 AND SPIN-1 W-BOSONS AT HIGH ENERGIES. Linsker, Ralph (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies. Columbia Univ., New York. Dept. of Physics). [1971]. 53p. Dep. NTIS.

The total cross section is calculated for the resonant process $l^\pm + Z \rightarrow l^\pm + Z' + B^0 \rightarrow l^\pm + Z' + (\text{hadrons or leptons})$, where $l = \mu$ or e, and B^0 is the hypothetical massive spin-1 boson of electromagnetic interactions, proposed by Lee and Wick. Several (Z,Z') cases were studied, corresponding to elastic scattering of protons and neutrons (with and without an exclusion principle), coherent scattering of spin-0 nuclei, and inelastic scattering of protons (in which case Z' denotes a nucleon resonance or hadronic system in the continuum). Detailed structure function data are used to improve the accuracy of the inelastic scattering calculation. At a beam energy of 200 to 300 GeV, the cross section exceeds 10^{-36} cm^2, provided the B^0 mass is not much greater than 10 GeV. Details of the calculation are given with results corresponding to NAL and higher energies. The cross section is also computed for the resonant process $\bar{\nu}_l(\nu_l) + Z \rightarrow l^\pm + Z' + W_0^\mp \rightarrow l^\pm + Z' + (\text{hadrons or leptons})$ and for the extensively studied semi-weak process $\bar{\nu}_l(\nu_l) + Z \rightarrow l^\pm + Z' + W_1^\mp$, where $W_{0,1}^\pm$ are scalar and vector weak intermediate bosons. The cross section for $W_0^\pm$ production with $l = \mu$ is found to be at least an order of magnitude smaller than that for $W_1^\pm$, in nearly all regions of interest. The $W_0^\pm$ production cross section for inelastic scattering of protons is comparable to that for elastic scattering in the regions of interest; whereas in the B^0 and $W_1^\pm$ cases, the main contribution to the total cross section for production of protons is elastic. (auth)

18918 (NYO–3829-82) GENERAL PHENOMENOLOGICAL ANALYSIS OF THE K_{l3} EXPERIMENTS. Tarter, J. M. (Pittsburgh Univ., Pa. Dept. of Physics). Oct 1971. Contract AT(30-1)-3829. 28p. Dep. NTIS.

A general parameterization is developed for the Dalitz-plot density and the charged lepton's polarization in K_{l3} decay. This parameterization is based only upon inhomogeneous Lorentz invariance and charge and lepton conservation, but its results appear strikingly similar to the V-A results. It is discussed how a general current–current Lagrangian fits into this parameterization. Then the theoretical framework of K_{l3} is analyzed for the meaning of the different experimental determinations of ξ, and restrictions are derived on the theoretical modifications which could significantly improve the theoretical-experimental agreement in K_{l3} measurements. Finally, several possibilities are suggested for experiments to probe into modifications of the usual theoretical framework of the K_{l3} decay, especially the modifications of the phenomenological V-A leptonic current. (auth)

18919 (NYO–3829-85) KINEMATICS OF K_{l3} DECAY AMPLITUDES AND RELATIVISTIC EQUATIONS FOR SPIN-ZERO PARTICLES. Willey, R. S.; Winternitz, P.; Yao, Tsu (Pittsburgh Univ., Pa. Dept. of Physics). Dec 1971. Contract AT(30-1)-3829. 8p. Dep. NTIS.

The standard S-matrix kinematic analysis is applied to the K_{l3} decays to show that the form factors $f_s(t)$ are free of kinematic singularities or constraints. The general form of the matrix elements of the vector current and its divergence in the Duffin–Kemmer formalism are determined and shown to be consistent with the general kinematic analysis. (auth)

18920 SEARCHES FOR INTERMEDIATE BOSONS. Lipmanov, E. M. (Yaroslavl State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 14: No. 9, 364-8(5 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 9, 529-34(5 Nov 1971).

With the assumption that the main method for the observation of intermediate bosons is the detection of their decay, it is shown that if one used a multicurrent theory of weak interactions of the Gell-Mann–Goldberger–Kroll–Low type there is a unique possibility of an appreciable difference between the intensities of the diagonal and nondiagonal reactions of the current–real-boson–current type. (J.F.P.)

18921 SOME IMPLICATIONS OF A POSSIBLE $\pi-\mu$ RESONANCE. Chhajlany, S. C. (Tata Inst. of Fundamental Research Bombay); Pakvasa, S. Contract AT(04-3)-511. Lett. Nuovo Cim.; 3: No. 5, 194-6(29 Jan 1972).

It is shown that the contribution of the heavy lepton μ^* to the anomalous magnetic moment of the muon can lead to bounds on the width $\Gamma(\mu^* \to \mu\pi)$. A brief summary is given of the effects that can arise through μ^* in different processes. (L.B.S.)

18922 RELATIVISTIC WAVE EQUATIONS DESCRIBING THE NEUTRINO. Santhanam, T. S.; Tekumalla, A. R. (Inst. of Mathematical Sciences, Madras). Lett. Nuovo Cim.; 3: No. 5, 190-3(29 Jan 1972).

The most general 4-component wave equations of the neutrino are analyzed. The C, P, and T properties of the equation are studied in detail and it is pointed out that the Hamiltonian in all these cases are non-Hermitian, unlike the case of the Weyl equation. (L.B.S.)

18923 SPIN-ONE W-BOSON PRODUCTION VIA MUON BEAMS. Fearing, Harold W. (Los Alamos Scientific Lab., N. Mex.); Pratap, Mahendra; Smith, Jack. Phys. Rev., D; 5: No. 1, 158-77(1 Jan 1972).

W bosons may be produced by muon beams in the reactions $\mu + Z \to \nu + Z + W$ (projectile fragmentation) and $\mu + p \to \mu + n + W$ (target fragmentation). Using a model where strong-interaction effects are introduced via phenomenological form factors, the target-fragmentation process is studied, concentrating on energies and W-boson masses appropriate to NAL. Total cross sections and angular and energy distributions are given for the W boson and the final muon and these results are compared with those obtained in the projectile-fragmentation reaction. Our calculation includes the possibility of an anomalous magnetic moment for the W boson. (auth)

18924 SU(3) × SU(3) SYMMETRY AND K_{l3} DECAYS. Mathur, V. S.; Yang, T. C. (Univ. of Rochester, N. Y.). Phys. Rev., D; 5: No. 1, 246-56(1 Jan 1972).

The problem of the quadratic dependence on momentum transfer of the form factors in K_{l3} decay is analyzed. Assuming that the (3,3*) + (3*,3) model provides a reasonable description of approximate SU(3) × SU(3) symmetry, several new sum rules are written down which involve form factors defined at different momentum transfers. A solution of the various K_{l3} parameters is obtained and discussed. (auth)

18925 TRIANGLE GRAPHS, CURRENT ALGEBRA, AND K_{l3} DECAY. Scadron, Michael D. (Univ. of Arizona, Tucson). Phys. Rev., D; 5: No. 1, 188-92(1 Jan 1972).

A new low-energy theorem for K_{l3} decay as the momentum transferred to the lepton pair vanishes. Saturating the axial-vector channel with the pion and the baryon-antibaryon intermediate states, the result $\xi(0) \simeq -1$ while at the same time preserving the Callan–Treiman relation. (auth)

18926 NONLEPTONIC DECAYS OF HYPERONS. Nagai, Y. Ernesto (Michigan State Univ., East Lansing). Phys. Rev., D; 5: No. 1, 60-5(1 Jan 1972).

Once-subtracted dispersion relations are written for the amplitudes of the nonleptonic decays of hyperons. The subtraction constants are given by equal-time commutators and, after the low-mass baryon intermediate states are separated, the remaining dispersion integrals over higher-mass resonances are evaluated in the framework of the Regge theory. A four-parameter best-fit solution to both the s- and p-wave amplitudes is found to be in very good agreement with experiment. (auth)

18927 RADIATIVE WEAK DECAYS OF HYPERONS. Nagai, Y. Ernesto (Michigan State Univ., East Lansing). Phys. Rev., D; 5: No. 1, 66-9(1 Jan 1972).

Current-algebra techniques and Low's soft-photon theorem are applied to evaluate the amplitudes of the radiative weak decays of hyperons. The calculated branching ratio and asymmetry parameter for the decay $\Sigma^+ \to p + \gamma$ are in very good agreement with recently measured values. (auth)

18928 NONLEPTONIC HYPERON DECAYS IN A CURRENT–CURRENT QUARK MODEL. Gronau, Michael (California Inst. of Tech., Pasadena). Phys. Rev., D; 5: No. 1, 118-24(1 Jan 1972).

The symmetric quark model is used to provide an explanation of the S- and P-wave nonleptonic hyperon decays. The current-algebra approach, applied to the current–current weak Hamiltonian constructed of Bose-type quark fields, leads to a remarkable agreement with experiment. (auth)

18929 BOUNDS ON K_{l3}-DECAY FORM FACTORS. Radescu, Eugen E. (Inst. of Atomic Physics, Bucharest). Phys. Rev., D; 5: No. 1, 135-9(1 Jan 1972).

Certain bounds on K_{l3} decay parameters found recently by Li, Pagels, and Okubo are rederived and some new results are obtained with a simpler method based on a direct application of the maximum-modulus theorem for holomorphic functions. For an arbitrary value of the momentum-transfer variable t in the complex cut t plane, it is found that the domain of values which can be taken by the form factor d(t) of the divergence of the weak strangeness-changing vector current $V_\mu^{(K)}$ is bounded by a circle in the plane (Red(t), Imd(t)). The radius and the position of the center of this circle is expressed in terms of $f_+(0)$ and of the propagator $\Delta(t)$ of the divergence of $V_\mu^{(K)}$. (auth)

18930 WEAK INTERACTIONS AT HIGH ENERGIES. Appelquist, Thomas (Harvard Univ., Cambridge, Mass.); Bjorken, James D. Phys. Rev., D; 4: No. 12, 3726-37(15 Dec 1971).

The weak interactions are discussed from an S-matrix point of view in order to make some qualitative statements about high-energy behavior. In order to separate the weak interactions from others as much as possible, attention is focused on the weak interactions of leptons neglecting electromagnetism. The consequences of imposing the constraints of unitarity and analyticity on weak amplitudes whose low-energy behavior is assumed to be correctly given by the usual Fermi theory (including the possibility of neutral currents) are examined. Corrections to the low-energy limit are first studied by using the Mandelstam iteration to express all lepton–lepton two-body scattering amplitudes to third order in the Fermi constant in terms of a small number of subtraction constants. Speculations beyond perturbation theory are made. Some consequences of forward dispersion relations are discussed and a mechanism is proposed for providing the necessary damping of weak amplitudes at high energies. The mechanism is the existence of the intermediate vector boson coupled weakly to leptons but interacting strongly with itself. Some consequences of this hypothesis are examined. (auth)

18931 RADIATIVE CORRECTIONS TO THE GOLDBERGER-TREIMAN RELATION: HIGH-FREQUENCY CONTRIBUTIONS. Sirlin, A. (New York Univ.). Phys. Rev., D; 5: No. 2, 436-44 (15 Jan 1972).

The second-order electromagnetic corrections to the Goldberger–Treiman relation are discussed. It is shown that when this relation is expressed in terms of physical coupling constants and masses, renormalized by electromagnetism, the residual electromagnetic corrections are finite. The derivation assumes, among other things, the existence of operator-product expansions at short distances and Wilson's enumeration of the fields of low dimensionality. Furthermore, the hadronic matrix elements in the corrections of order α are treated in the PCAC (partial conservation of axial-vector current) approximation. Some observations are made concerning the applicability of PCAC to the study of radiative corrections. A new physical decay constant, f'_π, renormalized by electromagnetism, is introduced and determined from experiment. Some salient features of the theory of β decay to first order in α are reviewed, with particular emphasis on the role played by the renormalized constants. (auth)

18932 LIGHT-CONE COMMUTATORS AND A SUM RULE FOR HIGH-ENERGY NEUTRINO SCATTERING. Corrigan, Dennis (Univ. of Calgary, Alberta). Phys. Rev., D; 5: No. 2, 490-2 (15 Jan 1972).

Using canonical expressions for certain current commutators on the light cone, a sum rule which relates the structure function W_3 (arising from vector–axial-vector interference) measured in high-energy neutrino experiments to the structure functions measured in electroproduction was derived. (auth)

18933 WEAK INTERACTIONS OF COLLIDING LEPTON BEAMS WITH ENERGY 10^2 TO 10^3 GeV. Dolgov, A. D.; Okum, L. B.; Zakharov, V. I. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys.; B37: No. 2, 493-508(1972).

Weak V–A interaction of colliding lepton beams at high energies is considered. It is assumed that the weak coupling constant G is the only parameter inherent to the weak leptonic interactions so that terms of higher order become appreciable at total energy $2E = s^{1/4}$ of order $G^{-1/4}$. It is shown that for colliding lepton-antilepton beams 2 × 250 GeV, the contribution of weak interactions to the differential cross section of elastic scattering at angle $\theta \simeq 90°$ prevails over that of electromagnetic interaction. The

estimate of the weak cross section is based on the calculation of the imaginary part of the amplitude which is uniquely determined in the second order in G. Phenomenological description of the real part of the amplitude in the same approximation introduces a single unknown parameter. Provided the validity of dispersion relations with two subtractions is granted this parameter is related to the integral of total cross sections of ll and $l\bar{l}$ weak interactions. Terms of the third order in G are studied in a similar way and an estimation of the magnitude of these terms is given. (auth)

18934 ELECTRON–MUON MASS DOUBLET FROM GENERAL RELATIVITY. Sachs, M. (State Univ. of New York, Buffalo). Nuovo Cim.; 7B: No. 2, 247-64(11 Feb 1972).

A consequence of combining separate aspects of a research program toward the development of a self-consistent field theory of a closed system is examined. These were the separate studies that indicated that: the inertial mass of matter is derivable from an explicit dynamical relation in terms of the geometrical field that describes a closed system in general relativity, and the result of a self-consistent approach to electrodynamics that any region of space–time must be populated with a countable and finite system of particle–antiparticle pairs, each in its ground state of null energy and null momentum. The latter followed from an application of Noether's theorem in a nonlinear field theory of electrodynamics. A linearized version of the theory that couples the matter and the metric field equations is studied. It is shown that the inertial mass field for spinor particles, being a 2-dimensional matrix field, has two distinct mass eigenvalues. From a study of the space–time curvature as due to the background gas of particle–antiparticle pairs, whenever the mass of an observed particle might be measured, semi-quantitative arguments are presented which imply that the ratio of these two eigenvalues for the electron mass doublet is the order of $3/2\alpha \cong 205$ (α being the fine-structure constant)—a number that is quite close to the muon-electron mass ratio. The analysis implies that to be consistent with the magnitude of the electron mass, the specific volume of the background gas of pairs is the order of $(10^{-15}\ \text{cm})^3$. It is also noted that a further implication of this background gas of pairs should be the appearance of "electron jets" and the accompanying electromagnetic radiation, in those parts of the universe where the temperatures of the ordinary mass distribution would reach values compatible with the dissociation energy of these pairs (corresponding to $T \sim 10^9$ °K)—this provides a possible explanation for some of the observed characteristics of quasars. (auth)

18935 DEEP INELASTIC NEUTRINO–NUCLEON INTERACTIONS. Clark, R. B.; Yamada, M. (Univ. of Texas, Austin). Nuovo Cim.; 7A: No. 3, 546-54(1 Feb 1972).

Deep inelastic neutrino-nucleon interactions are discussed under the assumptions of conserved axial vector current and equal-time commutation relations of currents. It is shown that the structure functions W_1 and W_2 for vector and axial vector currents are equal in the average sense with respect to the variable ν and are equal in the limit $\nu \to \infty$. The resulting expressions are then used to predict relations connecting deep inelastic neutrino and electron scattering. (auth)

18936 MODEL FOR PION DECAY OF K MESONS. Starinets, V. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 3, 349-51(May–Jun 1971). (In Russian).

The rule $|\Delta I| = \frac{1}{2}$ is not derived from generalized current–current form of interaction; the introduction of neutral currents brings about transitions where this rule holds. The subsequent treatment deals with quark Lagrange type of current–current and a quark hadron model, and concludes with several amplitudes of pion decay of K mesons. Eleven amplitudes and four parameters are involved; g and λ are excluded, thus seven theoretical relations between amplitudes are obtained, four of which are compared with experimental data. (K.S.W.)

18937 ROLE OF THE SHORT DISTANCE EFFECT IN NONLEPTONIC RADIATIVE DECAYS. Gaillard, M. K. (CERN, Geneva. CNRS, Orsay, France); Roy, Probir. Phys. Lett.; 38B: No. 4, 245-8(21 Feb 1972).

Short distance contributions to non-leptonic radiative decays arise from the presence of the gradient of the antisymmetric tensor current octet in the Wilson expansion. They can cause large SU(3) violation, preliminary evidence of which already exists for the reaction $\Sigma^+ \to p\gamma$. Relations among various nonleptonic decay parameters are obtained taking proper account of such terms and some decisive tests are proposed for their existence. (auth)

18938 SOME QUESTIONS ABOUT WEAK LEPTONIC CURRENTS AND NEUTRINO INTERACTIONS. Castoldi, P. (Univ. Libre, Brussels). Lett. Nuovo Cim.; 3: No. 7, 281-6(12 Feb 1972).

Three somewhat related questions about weak leptonic interactions, which have not received a definite experimental or theoretical answer, are discussed. These are concerned with diagonal interactions, neutral leptonic currents, and neutrino electric form factors. (L.B.S.)

18939 MESON $\to \gamma l\bar{l}$ DECAY AS A TEST OF A $K_L \to \mu^+\mu^-$ PUZZLE. Miyazaki, T. (Tokyo Univ. of Education). Lett. Nuovo Cim.; 3: No. 7, 294-8(12 Feb 1972).

It is shown that if CP and CPT invariance holds, the branching ratio for $K_L \to l\bar{l}\gamma$ is much larger than for $K_L \to l\bar{l}$ and the measurement of these processes would yield a test for $K_L \to \mu^+\mu^-$ puzzle. (L.B.S.)

18940 STRUCTURE OF THE WEAK INTERACTION. Brandt, R. A. (CERN, Geneva); Vinciarelli, P. Lett. Nuovo Cim.; 3: No. 6, 254-6(5 Feb 1972).

The basic ideas are presented of a highly speculative theory in which the weak force is a weak manifestation of a generalized electromagnetism. The strength of the weak interaction, its violation of P and C, and the CP violation responsible for $K_1^0 \to 2\pi$ decay are accounted for. Also the criteria of symmetry and elegance of the theory seem to be well satisfied. (J.F.P.)

18941 NEUTRINO HELICITY. Ayub, S. M. Pak. J. Sci. Ind. Res.; 14: No. 3, 201-4(Jun 1971).

The possibility of right-handed neutrinos is considered. The theory of weak interactions with parity violation and beta decay theories are discussed. (J.F.P.)

Strong (General)

Refer also to abstract 19136.

18942 DIFFRACTIVE POMERANCHUKON BOOTSTRAP AND INCLUSIVE EXPERIMENTS. Silverman, Dennis; Ting, Peter D.; Yesian, Harry J. (Univ. of California, San Diego, La Jolla). Phys. Rev., D; 5: No. 1, 94-108(1 Jan 1972).

A bootstrap of a diffractive Pomeranchuk singularity which gives rise to constant total cross sections is carried out in the framework of a multiperipheral model for particle production in which the Pomeranchuk singularity is exchanged at most once. The results for multiplicity distributions and inclusive experiments are presented and contrasted with those of multi-Pomeranchukon-exchange models in order to provide tests for the nature of the Pomeranchuk singularity. In this diffractive model the single-particle spectrum has a limiting distribution at high energies, but does not have pionization. As a consequence, the average multiplicity, $\bar{n}$, is asymptotically constant. A set of coupled nonlinear integral equations for the Pomeranchukon residue functions are derived and solutions are presented which explicitly exhibit factorization. The model predicts that the elastic contribution saturates unitarity at $t \approx -0.6\ \text{GeV}^2$, where the P′ Regge trajectory passes through zero. (auth)

18943 NONLINEAR HADRON COUPLINGS FROM DIVERGENCE CONDITIONS. III. SU(3) MULTIPLETS. Gupta, Suraj N.; Weihofen, William H. (Wayne State Univ., Detroit). Phys. Rev., D; 4: No. 12, 3693-3703(15 Dec 1971).

The Lagrangian density for a system of the pseudoscalar-meson nonet, the vector-meson nonet, and the spin-$\frac{1}{2}$-baryon octet is obtained by the SU(3) extension of the nonlinear Lagrangian density for pions, ρ mesons, and nucleons. The nonpolynomial Lagrangian density for the pseudoscalar mesons is derived by a general procedure, which is applicable to all models and includes a rigorous treatment of the mass term. The effect of the SU(3)-symmetry breaking is taken into account by introducing the mass matrix, and the broken divergence conditions for the vector and axial-vector currents are given in an explicit form. (auth)

18944 LIGHTLIKE QUARK MODEL AND CURRENT DENSITIES. Domokos, G. (Johns Hopkins Univ., Baltimore). Phys. Rev., D; 4: No. 12, 3708-16(15 Dec 1971).

A field theory of quarks is formulated, with quark states being defined on space-time surfaces with lightlike normals. The general structure of the field theory is discussed. It is found that single-particle observables and current densities, in particular, have approximately a free-field structure if the ground state is strongly degenerate. The structure functions of the nucleon in inelastic electron scattering exhibit a partonlike structure in any reference frame. (auth)

18945 VECTOR-MESON DOMINANCE AND GAUGE INVARIANCE. Capper, D. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 4: No. 12, 3777-87(15 Dec 1971).

A Lagrangian model of vector-meson dominance similar to that due to Kroll, Lee, and Zumino is considered. It is shown that for a correctly diagonalized and renormalized Lagrangian the conventional diagrams of vector dominance cannot be simply interpreted as Feynman diagrams, and it is not possible to derive the usual current-field identity. However, it is still possible to derive ρ universality, provided the photon and vector meson couple to the same conserved hadronic current, and also to derive a somewhat modified form of pole dominance consistent with a zero photon mass. The formalism presented also provides a particularly simple technique for calculating the hadronic contributions to the magnetic moment of the muon. (auth)

18946 FULLY-SYMMETRIC DUAL MODELS AND LORENTZ INVARIANCE. Musto, R. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples); Nicodemi, F.; Paciello, M. L.; Taglienti, B. Nuovo Cim.; 7A: No. 2, 407-16(21 Jan 1972).

An attempt is made to clarify the origin of the projective invariance in dual-resonance models in terms of the Lorentz group. It is found that the assignment of external particles to irreducible representations of $SL_{2,C}$ and the requirement that this group be an invariant group of the amplitude together with some physical requirements lead to the fully symmetric model proposed by Shapiro and Virasoro. Only the value $\alpha(0) = 2$ for the trajectory intercept is possible. (auth)

18947 MULTIPARTICLE INTERACTIONS. Goldsack, S. J. (Imperial Coll. of Science and Tech., London). J. Phys., A (London); 5: No. 1, 27-66(Jan 1972).

A review is given of some recent work on the phenomenology of multiparticle interactions of hadrons. The treatment is in breadth rather than depth. (auth)

18948 ALTERNATIVE EXPANSION IN THE COUPLING CONSTANT OF DUAL MODELS AND RAPID SCALING. Gallardo, J. C.; Masperi, L. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 3: No. 7, 261-6(12 Feb 1972).

A consistent scheme is presented for estimating qualitatively the relative magnitude of the contributions of tree and loop graphs to inclusive cross sections. The implications of this perturbative expansion in the coupling constant on inclusive interactions are investigated. In particular, the question of early scaling in the fragmentation region is analyzed, and a new criterion is proposed to eliminate prominent energy-dependent contributions within a dual model which embodies the Harari–Freund conjecture. A confirmation of predictions in this scheme was found from experimental results on the $K^+ + p \rightarrow K^0 +$ anything at 5.0, 8.2, and 12.7 GeV/c. (L.B.S.)

18949 SLICED EXTENSIONS AND GELL-MANN–NISHIJIMA FORMULA. Cattaneo, U. (Catholic Univ., Louvain, Belgium. Catholic Univ., Nijmegen, Netherlands). Nuovo Cim.; 7A: No. 4, 839-55(21 Feb 1972).

A vector space, generated by the set of Hilbert spaces of one-particle states of the different hadrons, is proposed as representation space of groups which allow for classifications of hadrons in multiplets. With the aid of methods of Lie algebra extension theory, it is proved that the Gell-Mann–Nishijima formula is a particular case of an expression characterizing a class of classification schemes. This expression appears as the eigenvalue version of a formula in terms of operators on the Hilbert space of one-particle hadronic states. (auth)

Strong (Baryon No. = 0)

18950 (FRNC-TH-112) SOME RECENT DEVELOPMENTS OF THE REGGE MODEL USING TRAJECTORIES. VENEZIANO MODEL WITH SPIN, AND CUTS. Kaplan, Jean (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 108p. (In French and English). Dep. NTIS (U. S. Sales Only).

Thesis.

After resuming the experimental situation, the theoretical point of view is presented. The general restrictions (analyticity, crossing, amplitude limits), and the phenomenological use of crossing trajectories leading to duality and to the Veneziano model, are considered. The results obtained for the 1^-0^- scattering using the Veneziano model are presented. Proton–proton and proton–antiproton scattering at high energies are studied using a Regge-eikonal model. (France)

18951 (ORNL-4744) OPERATING INSTRUCTIONS FOR THE HIGH-ENERGY NUCLEON–MESON TRANSPORT CODE HETC. Chandler, K. C.; Armstrong, T. W. (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 40p. Dep. NTIS.

The high-energy nucleon-meson transport code HETC computes the transport of nucleons, charged pions, and muons through matter for energies up to several hundred GeV by using Monte Carlo methods. This report is primarily concerned with the programing aspects of HETC. Instructions for operating the code are given, and the code input is described. HETC is written in FORTRAN IV for the IBM 360/75 and IBM 360/91 computers. (auth)

18952 RELATIONSHIP BETWEEN ρ AND A_1 WIDTHS BY WEINBERG SUM RULES. Buchl. R. A.; Nigam, B. P. (Arizona State Univ., Tempe). Lett. Nuovo Cim.; 3: No. 5, 183-4(29 Jan 1972).

The relation $\Gamma_A = \sqrt{2}\,\Gamma_\rho$ is obtained from Weinberg spectral-function sum rules. (L.B.S.)

18953 DETERMINATION OF THE $\omega-\varphi$ MIXING ANGLES FROM WEINBERG'S SUM RULES. Acharya, R. (Duke Univ., Durham, N. C.); Aly, H. H. Lett. Nuovo Cim.; 3: No. 5, 169-72 (29 Jan 1972).

It is shown that the first and second Weinberg sum rules, when applied to the baryon and hypercharge currents, lead to the result that $\Theta_V \pm \Theta_B = \pi/2$, where Θ_V and Θ_B are the two mixing angles which characterize $\omega-\phi$ mixing. A unique nonperturbative value for the two mixing angles is predicted from this result combined with the current-mixing model results. Predictions are then made for experimental numbers such as $\Gamma(\phi \rightarrow K\bar{K})$, $\Gamma(V^0 \rightarrow l^+l^-)$, and the ratios of the photoproduction cross sections of ρ, ω, and ϕ. (L.B.S.)

18954 BROKEN COUPLING CONSTANTS, SMOOTHNESS, AND SCALAR MESONS IN THE GELL-MANN–OAKES–RENNER MODEL. Dutt, Ranabir (Technion-Israel Inst. of Tech., Haifa); Eliezer, Shalom; Nanda, Priyabrata. Phys. Rev., D; 4: No. 12, 3759-65(15 Dec 1971).

Considering SU(3)-octet broken scalar-pseudoscalar meson (PPS) couplings as well as "smoothness" in the chiral model of Gell-Mann, Oakes, and Renner (GMOR), the spectrum of scalar mesons is obtained in terms of the known masses of the pseudoscalar mesons only. The agreement of the predicted spectrum with experiment is reasonably good. The broken pieces of the coupling constants are determined as well and are found to be comparable to their corresponding symmetric pieces. The effects of the broken couplings in the numerical results, such as decay widths, were also examined. It is demonstrated that the usual assumption of the Goldstone bosons required by exact chiral symmetry emerges automatically from the smoothness relations. A few other interesting aspects are finally discussed. (auth)

18955 DIMENSIONS OF SCALE-INVARIANCE BREAKING AND THE BEHAVIOR OF THE PION'S MECHANICAL FORM FACTOR. Levin, D. N.; Palmer, D. R. (Univ. of Rochester, N. Y.). Phys. Rev., D; 4: No. 12, 3716-25(15 Dec 1971).

Okubo's recently strengthened inequality is applied to the pion's mechanical form factor, bounding the derivative of that form factor at zero momentum transfer by the magnitude of the same function in the timelike region. In the framework of a model of broken scale and chiral invariance these results are converted into bounds on the dimensions of scale-invariance breaking and on the derivative of the mechanical form factor. Supplementary conditions on the dimensions and on the mechanical form factor are provided by a generalized version of well-known low-energy theorems. A comparison of the information furnished by the inequalities and by the low-energy theorems leads to the following conclusions: In the standard sort of model, in which the entire SU(2) ⊗ SU(2)-violating term and the entire SU(3) ⊗ SU(3)-violating term have the same dimension, the mechanical form factor will be "nonsmooth" and probably will be subtracted. On the other hand, there is a second type of model, in which the entire SU(2) ⊗ SU(2)-violating term and the entire SU(3) ⊗ SU(3)-violating term have different dimensions (zero and two, respectively). In such a theory the mechanical form factor can be "smooth" and unsubtracted. (auth)

18956 s-CHANNEL UNITARITY CONSTRAINT OF THE MULTIPERIPHERAL BOOTSTRAP MODELS. Shei, Sun-sheng (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 12, 3704-8(15 Dec 1971).

The s-channel unitarity constraint of the multiperipheral bootstrap models is discussed. It is shown that, if the low-subenergy part of the kernel is weak, it is possible to have self-consistent Regge poles. On the other hand, if the low-

subenergy part of the kernel is strong, self-consistent Regge poles cannot be obtained. In this case the most important J-plane singularity is a cut with branch point at 1, and the $\pi-\pi$ scattering amplitude goes to infinity slower than s/lns at high energy. (auth)

18957 VIRASORO MODEL AND FINITE-ENERGY SUM RULES. Kennedy, W. L.; Oh, C. H. (Univ. of Otago, Dunedin, N. Z.). Phys. Rev., D; 5: No. 2, 493-6(15 Jan 1972).

Finite-energy integer-moment sums are calculated for the Virasoro model for $\eta^0\eta^0$ scattering and used to show that the leading contribution satisfies finite-energy sum rules for sufficiently large cutoff energy. (auth)

18958 SCATTERING OF A CHARGED VECTOR MESON IN A STATIC FIELD AT HIGH ENERGIES. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Contract AT(30-1)-4101. Phys. Rev., D; 5: No. 2, 445-56(15 Jan 1972).

The scattering of a charged vector meson (without the anomalous magnetic moment) in a static field is studied. The scattering amplitude for such a process is obtained explicitly in the case of a central field. It is found that the simple-exponentiation form of the eikonal approximation does not occur. (auth)

18959 CROSSING AND PHYSICAL PARTIAL-WAVE AMPLITUDES. Basdevant, J. L.; Le Guillou, J. C.; Navelet, H. (CERN, Geneva). Nuovo Cim.; 7A: No. 2, 363-96(21 Jan 1972).

The implications of crossing and analyticity properties on partial-wave amplitudes in the physical region are studied. The physical interest of the $\pi\pi$ equations recently written by Roy is shown; comparison with the Chew–Mandelstam equations is particularly instructive, and it is shown how these equations can be used: (a) to construct low-energy amplitudes in practice, and (b) to check the consistency of experimental data (a direct method for solving the "up–down" ambiguity and calculating s-wave scattering lengths is obtained). The Martin inequalities and the sum rules for which they are derived are then reconsidered and it is shown that they can be used in a more powerful way. These considerations and results give strong support to the model of Le Guillou, Morel and Navelet for $\pi\pi$ s-waves. The general method for deriving physical-region crossing equations for arbitrary processes is given, in particular $\pi N \to \pi N$. (auth)

18960 THREE-BODY INTERFERENCE: PARAMETRIZATION OF THE MIXING STATES AND TIME-REVERSAL INVARIANCE. Gien, T. T. (Memorial Univ. of Newfoundland, St. John's). Nuovo Cim.; 7A: No. 3, 511-31(1 Feb 1972).

Formalisms are developed for the problem of three-body mixing. The mixing states are parametrized in the most general case without assuming any kind of symmetry for the interference process. The conditions imposed by time-reversal invariance on the mixing parameters are found. The elements of the mass matrix are calculated in terms of the mixing parameters and its eigenvalues. Finally, useful approximate expressions valid only in some special circumstances are given for possible practical applications. (auth)

18961 THREE-BODY INTERFERENCE: MASS-MATRIX FORMULA AND UNITARITY SUM RULES. Gien, T. T. (Memorial Univ. of Newfoundland, St. John's). Nuovo Cim.; 7A: No. 3, 532-45(1 Feb 1972).

The mass-matrix formula and the unitarity sum rules are derived for the 3-body mixing problem by treating the mixing entities as decaying objects. Conditions imposed by time-reversal invariance on the mixing parameters are also rederived by a somewhat different method of approach. Some immediate implications of the formulas and equations obtained are discussed within the $\rho-\omega-\varphi$ mixing case. (auth)

18962 HARD-PION CURRENT-ALGEBRA PREDICTIONS OF A_1-MESON DECAYS. Polito, P. J. (Springfield Coll., Mass.); Vaughn, M. T. Nuovo Cim.; 7A: No. 2, 449-60(21 Jan 1972).

Standard hard-pion current-algebra techniques are extended to obtain predictions of decay widths for various decays of the A_1-meson. The decay $A_1 \to \rho + \pi$ in which the ρ-meson is treated as a stable particle, and the decay mode $\pi + \gamma$ are discussed. Then we discuss the chain $A_1 \to \rho + \pi \to 3\pi$. Interference effects which appear in the decay $A_1 \to \rho + \pi \to 3\pi$ are carefully analysed and computed numerically. Comparison of numerical results for the decay widths of $A_1 \to \rho + \pi$, $A_1 \to \pi + \gamma$ and $A_1 \to \rho + \pi \to 3\pi$ (including interference effects) is made between the standard hard-pion current-algebra models and the current smoothness model of Vaughn. The procedure followed here differs from the standard current-algebra approaches in that pole dominance on the vector-current propagator is not assumed but some of the continuum contributions to the vector-current propagator are included. (auth)

18963 IMPROVEMENT OF SOME RIGOROUS INEQUALITIES ON S AND P WAVES FOR $\pi-\pi$ SCATTERING. Brander, O. (CERN, Geneva). Nuovo Cim.; 7A: No. 2, 435-48(21 Jan 1972).

The inequalities of Auberson, Brander, Mahoux and Martin are investigated with respect to the possibility of making them sharper by using also the positivity of the derivative of the absorptive part. It is found that some of the inequalities can indeed be improved. (auth)

18964 MULTIPERIPHERAL BOOTSTRAP MODEL WITH SU_3 MULTIPLETS. Wyld, H. W. (CERN, Geneva). Nuovo Cim.; 7A: No. 3, 632-44(1 Feb 1972).

The ABFST multiperipheral bootstrap model, studied recently by various authors with SU_2 multiplets (ρ and f mesons etc., exchanged between π-mesons), is enlarged to use SU_3 multiplets (octets of vector mesons, nonets of tensor mesons etc., exchanged between octets of pseudoscalar mesons). It is found that this increases the effective strength of the interaction slightly, but not enough to yield output trajectories with the correct intercepts. The calculation appears to yield f and f′ trajectories but no pomeron trajectory. Exchange degeneracy is broken for the output trajectories in this type of model in which an interaction potential is iterated, and this seems to be a serious difficulty. (auth)

18965 UNITIZED CURRENT ALGEBRA AND THE $A_1\rho\pi$ SYSTEM. Ecker, G. (Univ., Vienna). Acta Phys. Austr.; 33: No. 1, 67-70(1971). (In German).

The SU(2) × SU(2) current algebra limits the amplitude of a given system by the so-called Ward identities. Each solution of these relations therefore fulfills all conditions of the current algebra. The vertex functions with two axial current or its divergences and one vector current were considered. Values for once subtracted and twice subtracted solutions were tabulated. (J.S.R.)

18966 DUALITY AND FINAL-STATE INTERACTION IN THE DESCRIPTION OF $\bar{p}n \to \pi^+\pi^-\pi^-$ AT REST. Pokorski, S. (Univ. of Helsinki. Univ., Warsaw). Nuovo Cim.; 7A: No. 4, 828-38(21 Feb 1972).

A pole expansion of Veneziano four-point amplitudes which is convergent in the annihilation channel is used (a) to analyze the resonance content of the previously proposed dual descriptions of the reaction $\bar{p}n \to \pi^+\pi^-\pi^-$ at rest, and (b) to construct a dual model for this reaction which exhibits a clear connection to the final-state interaction model. The important predictions of duality and crossing symmetry are the existence of the daughter resonances in the $\pi\pi$ system (particularly ϵ and ϵ'), and the presence of a non-resonant background in the annihilation amplitude. A reasonable fit to the data is found with this model. (auth)

18967 CALCULATION OF THE CHARGE RADIUS OF THE PION. Kamal, A. N. (Rutherford High Energy Lab., Chilton, Eng.). Lett. Nuovo Cim.; 3: No. 6, 248-50(5 Feb 1972).

The real part of the pion form factor is calculated. It is found that this value is larger than the ρ-dominance value by almost 50%. (J.F.P.)

18968 D-WAVE DECAY OF A_1 INTO ρ AND π. Rafique, M. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 3: No. 6, 240-2(5 Feb 1972).

The value of the pion radius and the ratio of the decay widths of $A_1 \to \rho + \pi$ and $\rho \to 2\pi$ decays are found as consequences of a pure D-wave decay of A_1 into ρ and π. It appears that the discrepancy in the value of the ratio of decay widths results from SU(2) × SU(2) symmetry. (J.F.P.)

18969 DUAL CROSSING-SYMMETRIC REPRESENTATIONS WITH FINITE-WIDTH RESONANCES. Gaskell, R.; Contogouris, A. P. (McGill Univ., Montreal). Lett. Nuovo Cim.; 3: No. 6, 231-9(5 Feb 1972).

An amplitude is given with some properties similar to the Veneziano model, but with Regge trajectories complex above threshold and thus resonances of finite width. Ways to avoid the trouble with crossing symmetric representations for the asymptotic behavior of the amplitude of the process $\pi + \pi \to \pi + \omega$ are proposed. (J.F.P.)

Strong (Baryon No. = 1)

Refer also to abstract 18852.

18970 (ITF-71-80-E) MICROCAUSALITY AND ASYMPTOTICAL RELATIONS. Lomsadze, Yu. M.; Sabad, E. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 24p. Dep. NTIS (U. S. Sales Only).

The principle of a weak microcausality is formulated within

the framework of the Bogoljubov axiomatic approach based on the maximum wide space of the generalized functions bounded only by the requirement of the interpretability of amplitude. It is proved that in the closed complex upper energy halfplane the Phragmel–Liudelöf–Novanlinna generalized maximum principle is applicable to the weakly microcausal averaged asymptotic amplitude of arbitrary scattering process. It means that for such an amplitude, under corresponding conditions on the real axis all the asymptotic relations—the Pomeranchuk type theorems and other high-energy restrictions are valid. (auth)

18971 (LBL-38) ISOBAR MODEL FIT TO THE REACTION $N\pi \to N\pi\pi$: FITTING PROCEDURES AND FITS AT 1.7 GeV. Miller, Larry R. (California Univ., Berkeley. Lawrence Berkeley Lab.). 23 Nov 1971. Contract W-7405-eng-48. 70p. Dep. NTIS. Thesis.

The isobar model was fit to 50,000 events of the reaction $N\pi \to N\pi\pi$ in the energy region 1640 to 1800 MeV. Sixty combinations of partial waves and intermediate resonances were considered. The data were divided into six energy bins and independent fits were done to the model in each bin. The method of maximum likelihood was used, and at each energy no further binning or projecting was necessary. A solution was found that represents the data well by several criteria and is continuous among the six energy bins. This solution is stable and perhaps unique but it is surprising; instead of finding resonance-like phase changes in the production amplitudes of waves that pass through resonance in the elastic channel, it is found that virtually none of the production amplitudes change in phase (with respect to each other at least) over the whole energy region. (auth)

18972 (NP–19157) RESONANCES. Soeding, P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). [nd]. 74p. (In German). Dep. NTIS (U. S. Sales Only).

Data on the quantum numbers of resonances are recapitulated. Classification by the quark model is discussed. The phenomenology of resonances is discussed in detail. (J.S.R.)

18973 (ORO–3992-75) MODEL FOR THE MIXING AMONG THE 70 BARYON STATES BASED ON EXCHANGE DEGENERACY. Chiu, C. B.; Mitra, A. N. (Texas Univ., Austin. Center for Particle Theory). Feb 1972. Contract AT(40-1)-3992. 13p. (CPT–129). Dep. NTIS.

A model for the mixing between the 1^d, 8^d, 8^q, and 10^d states in the SU(6) 70, L = 1 supermultiplet based on exchange degeneracy conditions of the pseudoscalar meson-baryon scattering is presented. The mixing angles found are $\theta \sim 19.7°$, $\phi \sim 3.3°$ and $\phi' \sim 0$, where the angles are essentially between (1^d, 8^d), (8^d, 8^q) and (10^d, 8^d). This pattern of mixing is in good agreement with decay data. (auth)

18974 (ORO–3992-76) CALCULATION OF THE PROTON–NEUTRON MASS DIFFERENCE. Clark, Robert Beck; Yamada, M. (Texas Univ., Austin. Center for Particle Theory). Feb 1972. Contract AT(40-1)-3992. 15p. (CPT–130). Dep. NTIS.

The proton–neutron mass difference is calculated using a generalized form of Cottingham's formula, which includes the nonforward Compton scattering amplitude in the integrand. The duality principle is used to evaluate the contributions of all possible nucleon resonances. An analytic continuation of the formula with respect to t is made to obtain the mass difference. It is shown that the correct sign for the mass difference is obtained from the facts that the A_2 Regge trajectory $\alpha(t)$ satisfies $\alpha(0) \simeq \frac{1}{2}$ and that the A_2 residue function $\beta_1(0)$ defined in the text is negative, which can be proven by the finite energy sum rule. The mass difference is calculated to be $M_p - M_n \simeq -1.3$ MeV. (auth)

18975 CONSTANCY OF TOTAL CROSS SECTIONS AND THE PROCESS $\pi^- p \to \eta n$. Babaev, Z. R. JETP Lett. (USSR) (Engl. Transl.); 14: No. 9, 359-62(5 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 9, 523-6(5 Nov 1971).

The amplitude for the reaction $\pi^- + p \to \eta + n$ is related with the amplitudes of the reactions $\pi^- + p \to \pi^0 + n$ and $K^- + p \to K^0 + n$ using SU(3) symmetry. The possible consequences of the constancy of the total cross sections of the elastic processes for the interaction $\pi^- + p \to \eta + n$ are investigated. (J.F.P.)

18976 TRANSCENDENCE OF THE LAW OF BARYON-NUMBER CONSERVATION IN BLACK-HOLE PHYSICS. Bekenstein, Jacob D. (Princeton Univ., N. J.). Phys. Rev. Lett.; 28: No. 7, 452-5(14 Feb 1972).

The following result is stated: A black hole in its final state can be endowed with no exterior scalar, vector, or spin-2 meson fields. It is concluded that such a black hole is not subject to the strong interactions which are mediated by meson fields such as the π, ρ, and f, and that consequently a useful definition of baryon number cannot be given for such an object. (auth)

18977 DERIVATION OF BARYON RESONANCES FROM MESON DATA. Mac Gregor, M. H. (Univ. of California, Livermore). Lett. Nuovo Cim.; 3: No. 5, 197-205(29 Jan 1972).

The properties of a basis set of spinless excitation quanta, including binding energy systematics, are derived by reproducing the narrow-width spinless meson and kaon resonances. From the theory and properties of other meson resonances, the basis set is extended to include a fermion spinor S. With the complete basis set, and with the addition of small electromagnetic effects, the masses of the members of the baryon octet are reproduced to an accuracy of 0.1%. (L.B.S.)

18978 BACKWARD SCATTERING DUALITY CONSTRAINTS AND COUPLINGS OF THE ϵ-MESON. Dias de Deus, J. (University Coll., London). Lett. Nuovo Cim.; 3: No. 5, 185-9 (29 Jan 1972).

Superconvergence for backward meson-baryon scattering is explored in the framework of dual models. p- and s-wave resonances, vector mesons (ρ, ω, ϕ, K^*), and scalar mesons ($\epsilon(700)$, $\epsilon'(1060)$, $\epsilon'(1060)$, $\pi_N(1000)$, $\kappa(1000)$) in the first-resonance region are used in the saturation scheme. Coupling-constant relations for ϵ-meson are obtained. (L.B.S.)

18979 FINITE-ENERGY SUM RULES AND FIXED POLES FOR K^+p ELASTIC SCATTERING. Dubovoy, M. (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 1, 193-7(1 Jan 1972).

Assuming that exchange degeneracy is exact, the residue of the Pomeranchukon trajectory for K^+p elastic scattering is calculated from finite-energy sum rules and the low-energy phase shifts. It is shown that in order to be consistent with some recent results on s-channel helicity conservation for Pomeranchukon-dominated processes, at least one fixed pole must be included in the B amplitude, and in particular, this consistency is achieved by introducing a fixed pole at J = 0. (auth)

18980 TEST OF THE REGGE DIP MECHANISM. Kayser, Boris (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 5: No. 1, 198-204(1 Jan 1972).

Attention is drawn to the importance of the backward reaction $\pi^+p \to p\pi^+$ as a test of the wrong-signature nonsense Regge dip mechanism. If the observed dip in backward $\pi^+p \to p\pi^+$ is due to a wrong-signature nonsense zero, then a dip is also predicted to occur in $\pi^+p \to pp^+$. This prediction does not involve any arbitrary assumptions about fixed poles, exchange degeneracies, or absorptive Regge cuts. (auth)

18981 NEW DATA ON THE REACTION $K^+p \to \pi^+pK^0$ AND A DETAILED COMPARISON WITH THE VENEZIANO MODEL. Waluch, Victor; Flatte, Stanley; Friedman, Jerome H.; Sivers, Dennis (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 1, 4-14(1 Jan 1972).

Detailed fits to new data on the reaction $K^+p \to \pi^+pK^0$ at 12 GeV/c were made using the generalized Veneziano model with several different sets of assumptions. It is found that the quality of the fits depends to a large degree on the choice of kinematic factors, and it is also found that a good fit can be obtained only by using five adjustable parameters, multiple trajectories, and several kinematic factors. (auth)

18982 DUALITY, EXCHANGE DEGENERACY, AND REGGE-CUT MODELS IN $K^-n \to \pi^-\Lambda$ AND $\pi^+n \to K^+\Lambda$. Field, R. D. Jr. (Brookhaven National Lab., Upton, N. Y. Univ. of California, Berkeley). Phys. Rev., D; 5: No. 1, 86-94(1 Jan 1972).

Regge-cut models are investigated in the hope of understanding the specific mechanism responsible for the difference between the differential cross sections and behavior of the polarizations for $K^-n \to \pi^-\Lambda$ and $\pi^+n \to K^+\Lambda$. It is found that, although it is difficult to make any definite conclusions, Regge–Regge cuts probably do not produce large enough effects to be responsible for the observed differences between the differential cross sections. It is found that a model with exchange degeneracy (EXD) of K** and K* poles plus an exchange-degenerate pair of daughter trajectories (K**′ and K*′) plus Pomeranchukon-Regge cuts gives an excellent fit to all the data for both $K^-n \to \pi^-\Lambda$ and $\pi^+n \to K^+\Lambda$. In this model duality is exact for the bare poles. The poles produce an amplitude that is purely real when the corresponding duality diagram is nonplanar. The Pomeranchukon-Regge cuts "break" the EXD of the bare poles. The polarization can be understood simply in terms of the interference between the Regge poles and the Pomeranchukon-Regge cuts. The calculated values of the differential cross-section slope parameter b and the A and R parameters for $K^-n \to \pi^-\Lambda$ and $\pi^+n \to K^+\Lambda$ are displayed. (auth)

18983 DISPERSION-RELATION CALCULATION OF THE πN ELASTIC SCATTERING AMPLITUDE A′ FOR $-t \leq 0.20$ $(GeV/c)^2$ AND $0.575 \leq p \leq 20.0$ GeV/c. McClure, J. A. (Georgetown Univ., Washington, D. C.); Pitts, L. E. Phys. Rev., D; 5: No. 1, 109-18(1 Jan 1972).

The method, applicable for small-angle scattering, is based on dispersion relations written for the logarithm of the scattering amplitude and yields an expression for the phase in terms of integrals containing the modulus of the amplitude. Numerical values of the modulus, obtained from unpolarized differential cross-section data, are used as input to the integrals. Techniques are developed for minimizing the effect of the unphysical region and for treating the zeros of the amplitude. Although the primary objective is to calculate the high-energy amplitudes, the method can be used at all lab momenta $p \geq 0.575$ GeV/c, and as a check the phases are calculated for $0.575 \leq p \leq 2.07$ GeV/c. When the t dependence of the zero of the amplitude is taken into account, the phases, known from partial-wave analyses, are reproduced with discrepancies for π^+p (π^-p) no greater than 3% (9%). The amplitudes A'_i calculated at 2-GeV/c intervals from 2 to 12 GeV/c and at 15, 18, 20, and 30 GeV/c at squared momentum transfers of $-t = 0.0, 0.025, 0.05, 0.10, 0.15, 0.20$ $(GeV/c)^2$ are presented. (auth)

18984 REGGEIZED MULTIPLE-SCATTERING QUARK MODEL OF KAON–NUCLEON SCATTERING. Dean, N. W.; Luthe, J. C. (Iowa State Univ., Ames). Phys. Rev., D; 5: No. 1, 124-8(1 Jan 1972).

The Reggeized multiple-scattering quark model, which correctly predicted the flattening of pion-nucleon total cross sections subsequently observed at Serpukhov, is applied to the kaon-nucleon system. A good fit to all available $K^{\pm}$-nucleon elastic and charge-exchange data is obtained using the Pomeranchuk trajectory and exchange-degenerate P′-ω and ρ-A_2 trajectory pairs. The multiple-scattering terms produce subtractive Regge-cut effects which, disappearing as $(\ln s)^{-1}$, permit the total cross sections to rise very slowly toward an asymptote of $\sigma_\infty = 26.0 \pm 0.5$ mb. Predictions for these reactions up to 10,000 GeV/c are given. (auth)

18985 TRANSVERSE-MOMENTUM CORRELATIONS IN PRODUCTION PROCESSES. Blankenbecler, R.; Neff, Thomas, L. (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 1, 128-33(1 Jan 1972).

The distribution of the relative transverse momentum between particles of very different rapidities can yield information on the spatial structure of production mechanisms. These two-particle correlations of transverse momenta in multiparticle final states are shown to be useful in testing basic assumptions of theories of hadronic interactions. A simple phenomenological parametrization is presented as an aid to the analysis of experimental data and an absorptive multiparticle impact-parameter representation is utilized to interpret the physical significance of such correlations. Absorption in this model is shown to lead to the observed two-particle correlations and also to shoulders or dips in the transverse-momentum distributions. Relationships between transverse momenta and their conjugate spatial coordinates are shown to be of importance in understanding these correlations, which are as significant as those involving the currently popular longitudinal variables. A preliminary analysis of several reactions involving three- and four-body final states is reported. (auth)

18986 APPROACH TO THE INCLUSION OF SPIN IN THE VENEZIANO MODEL FOR $K^-p \to \bar{K}^0\pi^-p$ AND $K^-p \to K^{*-}p$. Adjei, S. A.; Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 5: No. 1, 139-46(1 Jan 1972).

A model combining the U(6,6) supermultiplet scheme with the generalized Veneziano model as a means of including spin in the latter is applied to the process $K^-p \to \bar{K}^0\pi^-p$. A four-point reduction of the amplitude, describing the subprocess $K^-p \to K^{*-}(890)p$, is obtained and its predictions compared with available data. Extremely favorable agreement with the data is obtained. (auth)

18987 STRUCTURE OF ABSORPTIVE REGGE CUTS IN THE πp CHARGE-EXCHANGE REACTION. Martin, Alexander; Stevens, Paul R. (Michigan State Univ., East Lansing). Phys. Rev., D; 5: No. 1, 147-57(1 Jan 1972).

The π^-p charge-exchange reaction above 5 GeV was analyzed in a Regge-pole-plus-cut model. The absorption generating the cut is parametrized according to a geometrical picture in terms of a strength, radius, and diffuseness, and dispersion is introduced by a phase proportional to the absorption. The input Regge pole has no nonsense-wrong-signature zeros. The rescattering is found to be strongly energy-dependent and quite different in shape from elastic scattering near 6 GeV. However, as the energy increases to 18 GeV it approaches elastic scattering in shape and magnitude. The phase of the rescattering amplitude is crucial to understanding the structure of the polarization. At 6 GeV the scattering amplitudes, and, in particular, their pattern of zeros, agree with recent model-independent analyses, and differ from the results of most previous absorptive-model calculations. In the geometrical picture which emerges, the imaginary parts of the partial-wave amplitudes are peripheral, in accord with ideas proposed by Harari and others. Moreover, the real part of the helicity-flip amplitude is also peripheral, but the real part of the helicity-nonflip amplitude is not. (auth)

18988 WIDE-ANGLE $\pi^-p \to \pi^0n$ DATA AND THE ρ TRAJECTORY. Dean, N. W. (Iowa State Univ., Ames). Phys. Rev., D; 5: No. 1, 133-5(1 Jan 1972).

New data on the $\pi^-p \to \pi^0n$ differential cross section in the wide-angle region are compared with an asymptotic form of the Regge amplitude valid in that limit. The ρ trajectory is approximately linear in t out to $t \approx -7$ GeV^2, but shows indications of preferring a less steep dependence such as $\alpha_\rho(t) = 2.11 - 2.65(-t)^{\frac{1}{2}}$ in the region $2 \lesssim -t \leq 7$ GeV^2. (auth)

18989 SCATTERING OF PIONS BY ANY TARGET IN DUAL-RESONANCE MODELS. Dias de Deus, J. (University Coll., London). Phys. Rev., D; 5: No. 2, 457-61(15 Jan 1972).

Guided by the Lovelace $\pi\pi$ formula, a set of constraints is proposed for any realistic Veneziano formulas for the scattering of pions by any target. One constraint, the vanishing of integrals over the (s,u) term in the forward directions due to a mechanism of local mass cancellations, is tested for $\pi\Sigma$, πN, $\pi\rho$, and $\pi\Delta$ scattering. This leads to the following predictions: $F/(F + D) = 1.4 \pm 0.1$ for the ratio of octet baryon–vector-(tensor-) meson couplings; $\Gamma_{A_2\rho\pi} \approx \Gamma_{\rho\pi\pi}/\sqrt{2} \approx 90$ MeV; $g^2_{\Delta^+\Delta^+\pi^+}/4\pi = 35$ in agreement with SU(6). (auth)

18990 LONGITUDINAL PHASE–SPACE ANALYSIS OF THE REACTION $\pi^+p \to \pi^+p\pi^+\pi^-$ AT 11.7 GeV/c AND COMPARISON OF THE REACTIONS $\pi^\pm p \to \pi^\pm\pi^+\pi^-p$ AT THE SAME ENERGY. Tomasini, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa); Bassler, E.; Sahini, M.; (and others). Nuovo Cim.; 7A: No. 3, 651-8(1 Feb 1972).

The reaction $\pi^+p \to \pi^+p\pi^+\pi^-$ at 11.7 GeV/c is analysed using longitudinal phase space (L.P.S.) plots with a sample of about 6000 events. The results are compared with those obtained by Kittel, Ratti and Van Hove in the analysis of the reaction $\pi^-p \to \pi^-p\pi^-\pi^+$ at 11 and 16 GeV/c. The four dominant sectors (1) $\pi^+p \to (3\pi)p$, (2) $\pi^+p \to \pi^+(p\pi^+\pi^-)$, (3) $\pi^+p \to (\pi^+\pi^+)(p\pi^-)$, (4) $\pi^+p \to (\pi^+\pi^-)(p\pi^+)$, are examined in some detail. In particular, sectors (1) and (2) are very similar to the corresponding ones observed for π^-p at the two momenta. The sectors (3) and (4) are compared in detail with the equivalent configurations observed in π^-p at 11 GeV/c, i.e., (3′) $\pi^-p \to (\pi^-\pi^-)(p\pi^+)$, (4′) $\pi^-p \to (\pi^+\pi^-)(p\pi^-)$. (auth)

18991 CRUCIAL TESTS OF THE VENEZIANO MODEL FROM DIP BEHAVIOR AT LOW ENERGY. Odorico, R. (CERN, Geneva). Nucl. Phys.; B37: No. 2, 509-40(1972).

A phenomenological exploration of the low-energy behavior of dips in some hadronic two-body processes (πp, Kp, $\bar{p}p$ scatterings and Λ production) is presented. It is found that such behavior is in most cases unexpectedly simple, and that in several cases dips and resonances describe simple patterns as the bare Veneziano formula suggests. Phase shifts are systematically used, and prove to be of critical importance to get an understanding of the low energy dip structure. The results of the study support physical significance of the Veneziano formula and contribute to clarify its phenomenological role. The view that the formula already contains important contributions from unitarity appears to be encouraged. On the other hand, the apparent limits of applicability of the formula seem to deflate the problem of avoiding parity doublets in the theory. (auth)

18992 PHASE SHIFT ANALYSIS OF K^+p SCATTERING. Miller, R. C. (Argonne National Lab., Ill.); Novey, T. B.; Yokosawa, A.; (and others). Nucl. Phys.; B37: No. 2, 401-20(1972).

Data on K^+p elastic scattering at 21 momenta covering the range 0.5 to 2.5 GeV/c were analyzed. Results of three phase shift analyses are presented. One of these is an energy independent accelerated convergence expansion (ACE) analysis in which high partial waves are included through use of conformal mapping as suggested by analytic approximation theory. The other two are an energy independent and an energy smoothed conventional analysis. The ACE method gave, with the same number of parameters, a 20% average improvement in χ^2 as well as more unique phase shift solutions. The high partial waves gave significant contributions to total and inelastic cross

sections. The ACE method is also sensitive to the value $g^2_{\Lambda\Sigma} = g^2_{K\Lambda N} + g^2_{K\Sigma N}$; the value $g^2_{\Lambda\Sigma} = 15.2 \pm 2.3$ is obtained. (auth)

18993 QUARK MODEL OF DIFFRACTIVE PRODUCTION WITH QUARK SPIN FLIP. Le Yaouanc, A.; Oliver, L.; Pene, O.; Raynal, J.-C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B37: No. 2, 541-51 (1972).

The presence of diffractive production of isobars with change of SU(6) representation (e.g., $\pi p \to \pi N^{*+}(1520)$) is interpreted, in the frame of the quark model by a quark spin flip. This quark spin flip must occur in the Breit frame of the p–N* transition, because it is there that the SU(6) nonrelativistic wave functions are expected to give the best results. The existence of a large quark spin flip in this frame is in turn related to the c.m. s-channel helicity conservation of elastic scattering. Quantitative calculations are made for $\pi p \to \pi N^*(1520)$ and for $\pi p \to \pi N^*(2190)$, quantitative agreement is obtained for both the shape and the absolute value of $d\sigma/d\Delta^2(\pi p \to \pi N^{*+}(1520))$; the results are not so good for the N*(2190) the reason is, according to us, the huge mass difference which leads to big uncertainties. No parameter is fitted. Also the spin structure and density matrix of all the N* in $\pi p \to \pi N^{*+}$ are predicted, and a very simple and striking result in the Gottfried–Jackson frame is obtained. Finally, the contradiction between the quark model and Morrison's rule is discussed. (auth)

18994 SU(3) COMPARISON OF φ AND K(890) PRODUCTION. Aguilar-Benitez, M.; Chung, S. U.; Eisner, R. L.; Samios, N. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 28: No. 9, 574-7(28 Feb 1972).

SU(3) invariance is utilized to relate the reactions $K^-p \to (\Lambda,\Sigma^0)\varphi$ with $\pi^-p \to (\Lambda,\Sigma^0)K(890)$ in the peripheral region. In all observable distributions, including the baryon polarization and the vector-meson density-matrix elements, the data are in good agreement with the SU(3) predictions. These observations lead to the conclusion that potential sources for the symmetry breaking, such as external-mass-dependent factors or absorptive effects, do not significantly affect the simple SU(3) picture. (auth)

18995 LONGITUDINAL MASS AND THE SMALL K/π RATIO IN VERY HIGH ENERGY COLLISIONS. Barshay, S.; Chao, Y.-A. (Univ. of Copenhagen). Phys. Lett.; 38B: No. 4, 229-31(21 Feb 1972).

The same phenomenological parametrization in terms of covariant longitudinal mass which correlates the structure and differences in transverse momentum distributions for $p + p \to \pi +$ (anything) and $p + p \to p +$ (anything) is shown also to give a good description of new data for $p + p \to K^0 +$ (anything). This leads to a natural possibility that the small K/π ratio at very high energies is simply due to the difference in longitudinal masses, which is a consequence of the nearly one-dimensional kinematics introduced by the transverse momentum cut-off together with the fact that the rest masses are split by the sources of SU(3)-symmetry breaking. (auth)

18996 ENERGY DEPENDENCE OF THE REACTIONS $K^\pm p \to K^{*\pm}(890)p$ AND $K^\pm p \to K^{*\pm}(1420)p$. Barloutaud, R. (CEN, Saclay, France); Borg, A.; Louedec, C.; (and others). Phys. Lett.; 38B: No. 4, 257-9(21 Feb 1972).

New high energy results for the reactions $K^-p \to K^{*-}(890)p$ and $K^-p \to K^{*-}(1420)p$ confirm a definite flattening in the energy dependence of the cross sections; such a flattening is not observed in the corresponding K^+ channels. The contribution of natural parity exchange at small t accounts for this effect and suggests a possible explanation in terms of pomeron (P) trajectory exchange, giving rise to ωP interference. (auth)

18997 ANALYSIS OF THE OBSERVED ANOMALY IN $\pi\pi$ s-WAVE SCATTERING NEAR $K\bar{K}$ THRESHOLD. Flatte, S. M.; Alston-Garnjost, M.; Barbaro-Galtieri, A.; (and others) (Univ. of California, Berkeley). Phys. Lett.; 38B: No. 4, 232-6(21 Feb 1972).

The character of the $\pi\pi$ s-wave scattering amplitude near 980 MeV is determined from the reactions $\pi^+p \to \Delta^{++}\pi^+\pi^-$ and $\Delta^{++}K^+K^-$ at 7 GeV/c. (auth)

18998 SATURATION OF SOME πN ISOSPIN BOUNDS. Hoehler, G.; Schmidt, W. (Univ., Karlsruhe, Ger. Institut fuer Experimentelle Kernphysik, Karlsruhe, Ger.). Phys. Lett.; 38B: No. 4, 237-40(21 Feb 1972).

The approximate saturation of the isospin bound for the backward amplitude is not due to a phase degeneracy but to the distribution of zeros and resonance poles. The saturation of S. M. Roy's bound for total elastic cross sections is explained. (auth)

18999 HIGH-ENERGY PHENOMENOLOGY OF πN AND KN FORWARD SCATTERING. Restignoli, M. (Univ., Rome); Schiff, D.; Violini, G. Nuovo Cim.; 7A: No. 4, 856-66(21 Feb 1972).

Recently proposed Regge-pole models are tested by means of FESR in πN scattering. The crossing odd amplitude does not require more sophisticated models than the pure ρ-exchange model. In the crossing even case, several models can reproduce the data within the same accuracy. The KN total cross-sections are analyzed and it is found that a conventional model allows a fit to the data within the errors (both statistical and systematic). (auth)

19000 POLARIZATION PARAMETERS AND RECONSTRUCTION OF AMPLITUDES FOR π–N SCATTERING. Giffon, M. (Univ., Lyon). Nuovo Cim.; 7A: No. 4, 705-26(21 Feb 1972).

From recent polarization parameter measurements for π^-p elastic scattering the various π-N scattering amplitudes are constructed. A comparison is made with the Regge model and FESR. Predictions are made for measurements of the parameters A and R relative to π^+p and charge exchange scattering. (auth)

19001 APPLICATION OF PARTIAL-WAVE CROSSING RELATIONS TO πN SCATTERING. Jakob, H.-P.; Krubasik, E.; Steiner, F. (Univ., Karlsruhe, Ger.). Fortschr. Phys.; 19: No. 1, 27-41(1971).

The partial wave crossing relations derived recently by STEINER are used for a calculation of the πN S-wave amplitudes in the region $8 \leqq s \leqq (M-1)^2$. The corresponding Argand diagrams show the pseudoresonance behavior predicted previously. The results for the real parts are compared with an independent calculation using fixed-t dispersion relations. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 18477 and 19218.

19002 (ITF–71-107-E) SHORT-RANGE NUCLEON–NUCLEON REPULSION AND LOW-ENERGY THREE-NUCLEON PARAMETERS. Kharchenko, V. F.; Shadchin, S. A.; Storozhenko, S. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 13p. Dep. NTIS (U. S. Sales Only).

It is shown by considering various potentials of a square form for the core repulsion and the attraction outside the core that low-energy three-nucleon parameters (binding energy of triton and n-d scattering lengths) are not sensitive to the ways of introducing of the repulsion at short internucleon distances. (auth)

19003 WORKING MODEL IN NUCLEAR AND HYPERNUCLEAR PHYSICS. Iwao, Syurei (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 5, 1407-19(Nov 1971).

A somewhat unconventional but unique model for predicting the binding energies of comparatively heavy p-shell hypernuclei is proposed after a close examination of the binding-energy formula for ordinary nuclei. A model constructed in this way is understood by interpreting the bound hyperon as a member of the Fermi gas inside the hypernucleus. An extension of this model to the hyperon binding in a nucleus of infinite size can be performed by making use of appropriate step functions and of newly defined parameters. A new formula for determining the well depth for the hyperon is derived by an examination of the physical meaning of the good fit obtained for the p-shell hypernuclei and of the extended formula. The well depth D is predicted to be 32 ± 0.2 MeV as an extrapolation from the p-shell hypernuclear data. The physical basis of the formula utilized in this fit is thoroughly discussed. The results obtained from this approach are compared with those in previous work of other authors. (auth)

19004 PRONG DISTRIBUTION IN p–p INTERACTIONS: AN APPLICATION OF THE CLUSTER EXPANSION. Chang, Shau-jin (Univ. of Illinois, Urbana); Yan, Tung-mow; Yao, York-peng. Phys. Rev., D; 5: No. 1, 271-4(1 Jan 1972).

The cluster-expansion result obtained recently for high-energy production processes is discussed, and it is applied to the prong distribution of p–p interactions. A good fit to the data can be easily obtained. The result suggests that multiparticle correlation effects are strong. (auth)

19005 DAMPED ONE- AND TWO-PION-EXCHANGE CONTRIBUTIONS TO RELATIVISTIC NUCLEON–NUCLEON SCATTERING. Bock, Charles W.; Haracz, Richard D. (Drexel Univ., Philadelphia). Phys. Rev., D; 5: No. 1, 39-47(1 Jan 1972).

Employing Gupta's unitary expansion of the scattering operator, the exact one-pion-exchange (OPE) and two-pion-exchange (TPE) nucleon–nucleon scattering phase parameters are evaluated at

18 energies in the elastic scattering range. These phase parameters are damped relative to the OPE and TPE results previously presented. The damping effect is large for values of $L \leq 3$, and it improves the undamped results in a comparison with the phenomenological values. The core phase parameters are drastically reduced and greatly improved by the damping effect. (auth)

19006 LOWER BOUND FOR THE TRIPLE POMERON VERTEX. Ellis, J. (Stanford Linear Accelerator Center, Calif.); Finkelstein, J.; Peccei, R. D. Phys. Lett.; 38B: No. 3, 174-6 (7 Feb 1972).

A lower bound is established for the triple-Pomeron contribution to inclusive distributions at small values of t, and it is observed that this minimum contribution is larger than that suggested by data on inclusive reactions, unless the Pomeron slope is extremely small. (auth)

19007 FINITE DIFFERENCE SOLUTION OF THE PARTIAL-WAVE SCHROEDINGER EQUATION. Stern, M. S.; Warburton, A. E. A. (Univ. of Hull, Eng.). J. Phys., A (London); 5: No. 1, 112-24(Jan 1972).

A method is developed for the numerical determination of bound states and the eigenvalues of the Lippmann–Schwinger kernel for any local interaction. The eigenvalues of the scattering kernel are analytically continued from negative energies by means of Padé approximants. The method is applied to calculations on low energy neutron–proton scattering. (auth)

19008 LONGITUDINAL MASS, INCLUSIVE TRANSVERSE-MOMENTUM DISTRIBUTIONS, PROTON–PROTON ELASTIC DIFFRACTION SLOPES, AND THE TOTAL CROSS SECTION. Barshay, S.; Chao, Y.-A. (Univ. of Copenhagen). Phys. Lett.; 38B: No. 4, 225-8(21 Feb 1972).

A simple, covariant function of longitudinal mass is used to describe the observed inclusive transverse momentum distributions in $p + p \rightarrow \pi^{\pm} +$ (anything) and $p + p \rightarrow p +$ (anything). Application of the same function to a phenomenological description of pp elastic diffraction scattering exhibits some nice analytic properties and predicts that the effective slope decreases in a definite way with increasing $|t|$. The pp total cross section is obtained in two independent ways from ISR experimental data and the resulting consistency suggests that the total inelastic and total cross sections may have increased at ISR energies. (auth)

19009 PHASE SPACE EFFECTS ON SINGLE PARTICLE SPECTRA. Chen, M.-S.; Paige, F. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett.; 38B: No. 4, 249-52(21 Feb 1972).

It is investigated whether the single particle spectra should behave like distributions in one- or three-dimensional phase space. From a statistical model and the observed momentum distribution, it is demonstrated that the phase space is essentially one-dimensional for $p_{lab} \geq 10$ to 20 GeV/c. (auth)

19010 DUALITY PREDICTIONS IN HIGH ENERGY MISSING MASS SPECTRA. Dias de Deus, J. (Univ., Paris); Lam, W. S. Phys. Lett.; 38B: No. 4, 220-4(21 Feb 1972).

By using the duality hypothesis of Freund and Harari, the high energy missing mass spectra of $pp \rightarrow pX$ were calculated from the relatively low energy missing mass data. The resonance contributions to the triple-Regge region were calculated from a finite energy sum rule which included all the diffractive N* resonances as well as the nucleon pole. The background contribution to the triple-Regge region was estimated from semi-local duality by averaging over the background of a particular resonance N* (1688). It was also found that the Pomeron treated as a simple pole couples much more weakly than the usual Reggeon to the inelastic processes in the triple-Regge region. (auth)

19011 OBSERVED AND PREDICTED MULTIPLICITIES IN VERY-HIGH-ENERGY INTERACTIONS. Grieder, P. K. F. (Univ., Bern). Nuovo Cim.; 7A: No. 4, 867-78(21 Feb 1972).

Recent hydrogen bubble chamber and hydrogen target multiplicity data are compared with the bulk of existing data over the entire experimental energy range, from 10 to 10^5 GeV. The data are compared with multiplicity predictions, derived from different interaction models. Included in the analysis are also results obtained from recent large-scale air shower simulations, in conjunction with experimental air shower data. Multiplicity tendencies of very-high-energy nucleon-nucleus interactions, as observed in emulsion and derived from air shower simulations, are discussed in view of the recent HBC and hydrogen target data. (auth)

19012 MATTER DENSITY MODELS AND ANTIPROTON–(EMULSION) NUCLEI ELASTIC SCATTERING AT 3 GeV/c. Kahn, R. (Centre de Recherches Nucleaires, Strasbourg). Nuovo Cim.; 7A: No. 4, 753-64(21 Feb 1972).

The antiproton–(emulsion) nuclei elastic scattering at 3 GeV/c laboratory momentum for four-momentum transfer squared $0.001 \leq |t|\ (\text{GeV/c})^2 \leq 0.017$ is interpreted following the model of Glauber. It is found that this model gives a satisfactory description of the experimental data even in the two extreme limits: (a) the multiple-scattering limit and (b) the optical limit. Two forms of density distributions were chosen, one corresponding to the model of Czyz and Maximon (nuclear density of s- and p-shell nuclei) and the other corresponding to the model of Bassel and Wilkin (product of densities of nucleons in s and p states). The results so obtained are compatible with each other. (auth)

19013 HIGH-ENERGY PROTON–PROTON SCATTERING, CURRENT–CURRENT INTERACTION, AND THE DROPLET MODEL. Lo, Shui-yin; Thompson, G. D. (Univ. of Glasgow). Lett. Nuovo Cim.; 3: No. 6, 223-6(5 Feb 1972).

A calculation of the p + p total cross section and the ratio of real to imaginary parts of the forward amplitude above 7 GeV/c is presented using the droplet model with current–current interaction. Also values of the differential cross section slope parameter are calculated for energies above 7 GeV/c and for all relevant t values. (J.F.P.)

19014 SCATTERING LENGTH FOR NEUTRON–NEUTRON SCATTERING WITH SEPARABLE POTENTIAL. Oberhummer, H.; Urban, P.; Zingl, H. (Univ., Graz). Acta Phys. Austr.; 33: No. 2, 115-20(1971). (In German).

The general properties of the separable potential are considered The special cases of the two-particle system whose interaction was described by a Coulomb and a separable potential and of pp scattering, especially the singlet s wave scattering ($^1S_0$) are calculated. The values of the separable potential obtained are compared with the values of the best local potentials. (J.S.R.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 18859, 19075–19079, 19092, 19138, and 19430.

19015 (COO-1545-101) ZERO MASS DIVERGENCES IN EXPANSIONS ABOUT CHIRAL AND SCALE SYMMETRY. McKay, Douglas W. (Kansas Univ., Lawrence); Palmer, William F. (Ohio State Univ., Columbus). [1971]. 17p. Dep. NTIS.

Singularities of expansions in the symmetry breaking parameters of chiral and scale asymmetric theories are studied, in the tree approximation, in polynomial Lagrangian models. The singularities are related to the appearance of zero-mass scalar fields, not necessarily Goldstone particles, at the radius of convergence of the expansion. Methods of avoiding these singularities are presented. (auth)

19016 (COO-1545-105) GENERALIZED GOLDSTONE THEOREMS IN AN EFFECTIVE LAGRANGIAN FRAMEWORK. Palmer, William F. (Ohio State Univ., Columbus). [1971]. 9p. Dep. NTIS.

A set of sum rules among coupling tensors of different rank is derived for spontaneously broken continuous symmetries in an effective Lagrangian framework. The sum rules, among which is the Goldstone theorem, constitute in this framework the physical content of that part of the spontaneously broken symmetry not contained in the conventionally realized subgroup which leaves the vacuum invariant, the latter sub-symmetry manifesting itself in Wigner–Eckart relations among coupling tensors of the same rank. (auth)

19017 STRUCTURE OF INTERNAL-SYMMETRY GROUPS. Kuo, T. K. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 12, 3637-43(15 Dec 1971).

It is shown that, given SU(2) and T invariance, their outer automorphisms, which must themselves be symmetries, form a one-parameter gauge group. Thus, from isospin conservation and time-reversal invariance, one gets hypercharge conservation. Similarly, from angular momentum conservation and T invariance, one has fermion-number conservation. Further, the well-known empirical relations $(-1)^Y = (-1)^{2I}$ and $(-1)^F = (-1)^{2J}$ are derived. (auth)

19018 INTERNAL-SYMMETRY GROUPS AND THEIR AUTOMORPHISMS. Kuo, T. K. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 12, 3620-37(15 Dec 1971).

It is proposed that outer automorphisms of degenerate internal-symmetry groups must be symmetry operators themselves. In general, however, they are hidden (spontaneously broken) symmetries. Consequences of this proposition are studied. It is found that internal-symmetry groups are not arbitrary but that their intrinsic properties play an important role. The existence of discrete symmetries (such as charge conjugation) follows naturally from assuming the continuous symmetry groups (such as gauge groups). It is also found that the enlargement of the isospin symmetry and parity leads directly to the chiral SU(3) × SU(3), so that the existence of an "exact SU(3) limit" is in principle not allowed. (auth)

19019 LECTURES IN THEORETICAL PHYSICS. VOLUME XIII. DE SITTER AND CONFORMAL GROUPS AND THEIR APPLICATIONS. Conference Held at Boulder, Colorado, June 29–July 3, 1970. Barut, Asim O.; Brittin, Wesley E. (eds.). Institute for Theoretical Physics Publications. Boulder, Colo.; Colorado Associated University Press (1971). 448p. (CONF-700656).

The conference included 29 papers one of which was abstracted previously in NSA. For an abstract of this paper see abstract number 25: 17537. Separate abstracts were prepared for 28 papers. (J.F.P.)

For abstracts of individual papers see: 18859, 18860, 18896, 19020–19031, 19042, 19043, 19051–19054, 19075–19079, 19107, and 19138.

19020 INTRODUCTION TO DE SITTER AND CONFORMAL GROUPS AND THEIR PHYSICAL APPLICATIONS. Barut, A. O. (Univ. of Colorado, Boulder). Lect. Theor. Phys.; 13: 3-25 (1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The general properties of de Sitter and conformal groups and the areas of their physical applications are reviewed in some detail. (J.F.P.)

19021 ONE-PARAMETER SUBGROUPS OF THE CONFORMAL GROUP OF SPACE-TIME AND IN GENERAL OF UNITARY GROUPS WITH AN INDEFINITE METRIC. Belinfante, Johan G. (Carnegie-Mellon Univ., Pittsburgh). Lect. Theor. Phys.; 13: 31-50(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

Some preliminary work on subgroup structure of the conformal group SU(2,2) and related groups is discussed. The conjugacy classes of one-parameter subgroups of the groups U(p,q) and SU(p,q) are studied. The geometric algebraic approach and general results of vector space theory and the general theory of linear operators and hermitean forms are used. (J.F.P.)

19022 CLASSIFICATION OF THE IRREDUCIBLE REPRESENTATIONS OF THE O(4,1) DE SITTER GROUP. Schwarz, Fritz (Univ. of Texas, Austin). Lect. Theor. Phys.; 13: 53-71(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

By M^5 is denoted the vector space of real 5-tupels $(x_1 \ldots x_5)$ in which the quadratic form $x_1^2 + \ldots + x_4^2 - x_5^2$ is given. The De Sitter group O(4,1) is the group of linear homogeneous transformations of the M^5 which leave this form invariant. At first one determines the irreducible representations of the identity component. These irreducible representations are extended in all possible ways to inequivalent representations of the whole group. (auth)

19023 MATRIX ELEMENTS OF FINITE TRANSFORMATIONS IN THE DE SITTER GROUP Sp(2,2). Holman III, Wayne J. (Middle East Technical Univ., Ankara). Lect. Theor. Phys.; 13: 73-96(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

Spinor basis states for the irreducible representations of Sp(2,2), the spinor covering group of the de Sitter group SO(4,1), are obtained by analytic continuation from those of the compact group Sp(4). An algorithm is established for the determination of matrix elements of finite transformations from the form of these basis states, and they are written down explicitly for all the unitary irreducible representations of Sp(2,2). (auth)

19024 GENERALIZED DIRAC AND MAJORANA REPRESENTATIONS OF SO(3,2). Jaffe, Leon (Univ. of Texas, Austin). Lect. Theor. Phys.; 13: 125-37(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The use of the Gel'fand-Zetlin formulas for $\overline{SO}(5)$ to obtain those unitary irreducible representations of $\overline{SO}(3,2)$ which have a discrete singleton reduction with respect to $\overline{SO}(3,1)$ [the "discrete Lorentz" representations] is considered. These discrete Lorentz representations can be regarded as generalizations of the Majorana and Dirac representations in certain cases. The method used also generalizes easily to discuss an analogous class of representations of $\overline{SO}(n,2)$. (auth)

19025 SOME CLASSES OF UNITARY IRREDUCIBLE REPRESENTATIONS OF THE GROUP $SO_0(4,2)$. Schwarz, Fritz (Univ. of Texas, Austin). Lect. Theor. Phys.; 13: 139-56(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The identity component $SO_0(4,2)$ of the group O(4,2) is usually called the conformal group. The following unitary irreducible representations (UIR's) of the group $SO_0(4,2)$ are determined: The UIR's which contain only the discrete series of $SO_0(4,1)$. The UIR's which change the discrete label of the $SO_0(4,1)$ representations only. The UIR's which remain irreducible under restriction to $SO_0(4,1)$. One begins always with the Lie algebra of the conformal group and constructs an irreducible representation of antihermitian operators of it. All representations obtained in this way can be extended to a UIR of the conformal group. (auth)

19026 UNITARY IRREDUCIBLE REPRESENTATIONS OF SU(2,2), REDUCTION WITH RESPECT TO AN ISO-POINCARE SUBGROUP. Yao, Tsu (Univ. of Pittsburgh). Lect. Theor. Phys.; 13: 157-74(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The unitary irreducible representations of SU(2,2), which is the covering group of the conformal group O(4,2) are studied. The reduction of these UIR's with respect to a subgroup E(3,1), which is isomorphic to the Poincare group, is obtained. (J.F.P.)

19027 COORDINATE TRANSFORMATIONS THAT FORM GROUPS IN THE LARGE. Mariwalla, K. H. (Arya-Mehr Univ. of Tech., Teheran). Lect. Theor. Phys.; 13: 177-91 (1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

One generally takes geometric symmetry group as motions (metric automorphisms). It is shown that both in nonrelativistic and relativistic mechanics there exist (well known) examples where the physical symmetry is larger than the group of motions of flat space into itself. Similar situations exist in general relativity. It is pointed out that there exists a wealth of coordinate transformation groups (both linear and nonlinear realizations of groups used in elementary particle theory) in both flat space and curved space-time which arise as automorphisms of some geometric entity such that the distance is left unchanged. Various possible approaches for application to elementary particle theory are suggested. (auth)

19028 NONCONTINUOUS REPRESENTATIONS OF LIE GROUPS. Pirrung, Bernd (Technische Univ., Clausthal-Zellerfeld, Ger.). Lect. Theor. Phys.; 13: 193-201(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The topics covered include the description of a physical system by means of group theoretical methods, the continuity of representations, proof of a general theorem for nonsolvable Lie groups, and noncontinuous representations in separable spaces. (J.F.P.)

19029 GENERALIZED O(2,1) EXPANSIONS. Cronstroem, C. (Inst. for Advanced Study, Princeton, N. J.). Lect. Theor. Phys.; 13: 205-18(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

A brief review is given of the O(2,1) expansion for a square-integrable scattering amplitude and its relation to the Sommerfeld-Watson transform. The conventional O(2,1) expansion is then generalized to cover the case of asymptotically growing but power bounded functions. Certain ambiguities inherent in the generalized O(2,1) expansion are discussed in detail. For simplicity only the case of two-body amplitudes with equal mass kinematics and no spin is discussed. (auth)

19030 EXPANSION THEORY AND THE LORENTZ GROUPS IN NON-CANONICAL BASES. Macfadyen, N. W. (Carnegie-Mellon Univ., Pittsburgh). Lect. Theor. Phys.; 13: 219-29 (1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The unexpected behavior of the SL(2,C) group in an SU(1,1) basis is examined. (J.F.P.)

19031 CLOSED ORBITS AND SO(4,2) SYMMETRY IN RELATIVISTIC TWO-BODY THEORY. Andersen, C. M.; von Baeyer, Hans C. (Coll. of William and Mary, Williamsburg, Va.). Lect. Theor. Phys.; 13: 329-36(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

A one-body theory with relativistic kinematics and SO(4,2) symmetry is formulated. This theory is generalized to a Poincare invariant two-body theory with the same symmetry. (J.F.P.)

19032 SCALE AND CONFORMAL TRANSFORMATIONS IN GALILEAN-COVARIANT FIELD THEORY. Hagen, C. R. (Univ. of Rochester, N. Y.). Phys. Rev., D; 5: No. 2, 377-88(15 Jan 1972).

It is demonstrated that there exists the possibility of defining scale and conformal transformations in such a way that these constitute exact invariance operations of the Schrödinger equation. Unlike the relativistic case there is only a single conformal transformation and the usual eleven-parameter extended Galilei group is consequently enlarged to a thirteen-parameter group. The generalization to the case of fields of arbitrary spin is carried out within the framework of minimal-component theories whose interactions respect scale and conformal invariance. It is found that the bare-internal-energy term can be used to break these additional invariance operations in much the same way as the mass term in special relativity. The generators and conservation laws associated with all space–time symmetries of minimal-component Galilean-invariant field theories are derived, it being shown that, in analogy to the relativistic case, the operators which appear in these equations can be redefined so as to allow the formulation of scale and conformal invariance entirely in terms of those operator densities relevant to the transformations of the Galilei group. (auth)

19033 DYNAMICS FROM THE POINCARE GROUP. II. LAGRANGIANS AND FIELDS. Hind, J. D. (Westfield Coll., London). Nuovo Cim.; 7A: No. 2, 293-310(21 Jan 1972).

The investigation of the possibility of describing interacting particles by nonlinear realizations of the Poincaré group is continued. Lagrangians, defined in terms of the invariant geometry, are introduced as an aid to calculation, and various expressions for the S-matrix are discussed. A particular nonlinear action of the group, describing the pion, rho and nucleon, is set up, and some investigations of it are conducted. Finally, the ultraviolet divergences of Lagrangian field-theory are shown to have a simple geometrical significance and their removal, by geometrical techniques, is discussed. (auth)

19034 SYMMETRY PRINCIPLES, CONSERVATION LAWS, AND DYNAMICS. Lohmus, J. (Inst. of Physics and Astronomy, Tallinn). pp 5-18 of Osakeste ja Valguse Maailmast. VI. Tallinn; Kirjastus Valgus (1971). (In Estonian).

A review of the role of symmetry principles in the understanding of the physical world is given. The following problems are discussed: the development and essence of the symmetry idea, a precise definition of symmetry, symmetry and conservation laws (Noether's theorem), laws of nature and Lorentz invariance, dynamical symmetries, and interrelations between dynamics and invariance properties. (J.F.P.)

19035 SOME REMARKS ON THE STRUCTURE OF COMPLEX SEMI-SIMPLE LIE ALGEBRAS RELATED TO THE REALIZATION OF DYNAMICAL SYMMETRIES. Bunchaft, F. (Istituto Nazionale di Fisica Nucleare, Naples). Lett. Nuovo Cim.; 3: No. 7, 287-93(12 Feb 1972).

It is proved that in any complex semi-simple Lie algebra g, with rank r, the union of descending sequences of greatest roots defines an equivalence class of sets $\{\alpha_+^i\}$ of r positive, linearly independent, commuting roots. This determines in g a conjugacy class of subalgebras b, constructed via the semi-direct sum of a Carton subalgebra h of g and a subalgebra whose weights are a set of roots $\{\alpha_+^i\}$. (L.B.S.)

19036 SATURATION OF DENSITY-CHARGE ALGEBRA. Young, K. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Lett.; 38B: No. 4, 241-4(21 Feb 1972).

It is shown, with rather general assumptions, that the $U(6)_W$ density-charge commutation relations at infinite momentum cannot be saturated with nonexotic states. (auth)

19037 GENERALIZATION OF CHIRAL SW_3 MODEL. Okubo, S. (Univ. of Rochester, N. Y.). Nuovo Cim.; 7A: No. 4, 765-78 (21 Feb 1972).

Assuming the algebra of currents, PCAC for pions, and some other technical conditions, it is proved that any Hamiltonian density H(x), whose SU_3-breaking component belongs to the $(3,3^*) \oplus (3^*,3)$ representation of the SW_3-group, must automatically have the following structure: $H(x) = H_0(x) + H_1(x) + H_2(x)$. $H_0(x)$ is invariant under SW_3, $H_1(x)$ breaks SU_3 but is invariant under SW_2, while $H_2(x)$ is invariant under SU_3 but violates SW_2. Also, $H_2(x)$ will vanish in the soft-pion limit. This model contains, as special cases, the schemes of Gell-Mann, Oakes and Renner, and of Glashow and Weinberg. (auth)

19038 ANGULAR MOMENTUM AND UNITARY SPINOR BASES OF THE LORENTZ GROUP. Huszar, M. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 3, 241-51(1971).

The matrix of the boost operator has a rather complicated form in angular momentum basis while it reduces to a diagonal form $e^{i\alpha v}$ in the unitary spinor basis. The overlap coefficients between the two bases turn out to be complex Wigner coefficients of the rotation group. With the aid of these coefficients an expression for the boost function is derived in terms of a power series in $e^{-2\alpha}$.

Applications (Electromagnetic and Weak)

Refer also to abstract 18924.

19039 QUESTION OF SPONTANEOUS GENESIS OF CP VIOLATION. Beg, M. A. B. (Rockefeller Univ., New York). Phys. Rev., D; 4: No. 12, 3810-11(15 Dec 1971).

The spontaneous model of CP violation is considered and the order-of-magnitude difficulties which detract from the experimental relevance of this model are discussed. (auth)

19040 MOESSBAUER TESTS OF TIME REVERSAL INVARIANCE. Hannon, J. P. (Rice Univ., Houston, Tex.). Nucl. Phys.; A177: No. 2, 493-512(1971).

A detailed analysis is given of the Moessbauer absorption experiments designed to test T invariance. Means by which the effects of a T violation can be separated from the initial and final-state atomic radiative interactions that simulate T noninvariance are discussed. (auth)

19041 CP VIOLATION AND $K_{S,L} \rightarrow \mu\bar{\mu}$ DECAYS. Mathur, Vishnu S. (Univ. of Rochester, N. Y.). Phys. Rev., D; 5: No. 1, 257-60(1 Jan 1972).

A discussion of CP violation in $K_{S,L} \rightarrow \mu\bar{\mu}$ is presented. It is argued on the basis of order-of-magnitude estimates for the absorptive and dispersive parts that a class of CP-violating theories is inconsistent with the present experimental information. Okubo's theory of CP violation, which lies outside this class, is also discussed. (auth)

19042 REPRESENTATIONS OF THE DYNAMICAL GROUP O(4,2) REALIZED IN THE DYONIUM ATOM. Barut, A. O. (Univ. of Colorado, Boulder). Lect. Theor. Phys.; 13: 337-48 (1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The bound and scattering states of two massless particles having both electric and magnetic charges, called dyonium, are considered. Dyonium and its energy spectrum, SO(4,2) representations characterized by an invariant parameter, the dyonium model in strong interactions, and infinite-component wave equations on the representation spaces of O(4,2) are discussed. (J.F.P.)

19043 DE SITTER ALGEBRAIC APPROACH TO ELECTROMAGNETIC INTERACTIONS. Dalton, B. J. (Florida State Univ., Tallahassee). Lect. Theor. Phys.; 13: 421-9(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

A reason is given from group theoretical arguments why the force pattern $F = qE + qV \times B$ should occur in nature. In the method used, it is assumed that the interacting particles are each separately described by a de Sitter momentum space. The composite group representation for the two particles and how it changes as the two extended particles move closer together or apart in the background X space are studied. (J.F.P.)

19044 RENORMALIZABLE SYMMETRY MODEL OF WEAK INTERACTIONS. Pugh, Robert E. (Univ. of Toronto). Phys. Rev., D; 5: No. 2, 474-81(15 Jan 1972).

A renormalizable model of weak interactions is presented. The leptons and the SU(3) quarks are classified in an $SU(4) \times SU(2)$ symmetry scheme in which the quantum numbers are charge, baryon number, lepton number, and weakness-a quantum number

that replaces the usual second lepton number. The coupling of a sextet of spinless bosons to the leptons and hadrons gives a theory of weak interactions that has universality, the correct selection rules, renormalizability, conserved vector current, and V−A in the local limit. Elastic $e\nu_\mu$ scattering is predicted. The intermediate scalar boson leads to μe and ee pairs in the conventional high-energy neutrino experiments but no $\mu\mu$ pairs are predicted. Some neutral-current effects are expected and these are consistent with present data. (auth)

19045 K-LEPTONIC DECAYS AND SPONTANEOUS BREAKDOWN OF CHIRAL SYMMETRY. Ferrari, R. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Fiorentini, G. Nuovo Cim.; 7A: No. 2, 397-406(21 Jan 1972).

Under the assumption of spontaneous breakdown of the axial part of chiral $SU_2 \times SU_2$ symmetry, the leptonic decays of K-mesons are studied. Low-energy theorems are derived and the results are compared with those of PCAC and current algebra technique. It is shown that the two methods give results corresponding to different limiting procedures while extrapolating the decay amplitude to zero pion energy. The conclusion is that the two methods give identical information about the physical decay amplitude. (auth)

19046 TESTS FOR ANGULAR MOMENTUM NONCONSERVATION IN WEAK INTERACTIONS OF HADRONS. Gal, A. (Hebrew Univ., Jerusalem); Franklin, J.; Sen, R. N.; Weil, C. Nuovo Cim.; 7A: No. 3, 497-510(1 Feb 1972).

Certain tests for possible angular momentum nonconservation in the weak interactions of strange particles are analyzed for feasibility. Available evidence from: (a) correlation between the Λ-Σ^0 polarizations in the process $\Sigma^0 \to \Lambda + \gamma$, and (b) $\bar{p}p$ annihilation at rest into neutral kaons, does not indicate angular momentum nonconservation. Further evidence should be obtainable from: (a) line shapes of x rays from K-mesic atoms, (b) regeneration of K_s from K_L (or its absence) due to magnetic fields, and (c) γ-rays from excited hypernuclei. (auth)

19047 (1, 8) ⊕ (8,1) SYMMETRY BREAKING AND K_{l3} DECAYS IN THE SU_3 SIGMA-MODEL. Barker, I. S. (Nuclear Physics Lab., Daresbury, Eng.). Lett. Nuovo Cim.; 3: No. 7, 267-70 (12 Feb 1972).

It was suggested that the values of ξ and λ_+ found in K_{l3} experiments indicate the presence of a term in the chiral symmetry-breaking Lagrangian which transforms as a member of a (1, 8) ⊕ (8, 1) representation of SU(3) × SU(3). A calculation of the symmetry-breaking parameter necessary to fit the experimental information is reported. It is found that a (1, 8) ⊕ (8, 1) symmetry breaking large enough to accommodate the K_{l3} results would lead to unacceptable consequences for the meson mass spectrum, within the framework of the SU(3) sigma model. (L.B.S.)

19048 POSSIBILITY THAT PULSES OF A LONG-RANGE FIELD ARE THE SOURCE OF CP NONINVARIANCE. Atkins, K. R.; Lande, K. (Univ. of Pennsylvania, Philadelphia). Nuovo Cim.; 7A: No. 4, 824-7(21 Feb 1972).

The possibility that pulses of a long-range field are the source of CP noninvariance in K^0_L decays is explored. An experimental test involving correlation in the decay of two $K^0_L \to \pi^+\pi^-$ is proposed. (auth)

Applications (Strong)

Refer also to abstracts 18943, 18946, 18949, 18954, 18955, 19239, and 19308.

19049 (COO-1545-106) SYMMETRY BREAKING ROLE OF κ MESON. McKay, Douglas W. (Kansas Univ., Lawrence); Palmer, William F. (Ohio State Univ., Columbus). [1970]. 25p. Dep. NTIS.

The symmetry breaking role of the κ meson is studied in the context of the (3,3*) + (3*,3) model and its role compared with that of the pseudoscalar mesons in PCAC. While PCAC and PCVC field-divergence identities may play parallel roles in some dynamical schemes, as in evident in many effective Lagrangian and "hard pion" calculations, the point of view that the vacuum is approximately SU(3) symmetric coupled with the order of chiral symmetry breaking counting of Dashen suggest a scheme in which the κ plays a subordinate or at least dynamically dissimilar role from that of the pion or kaons. This possibility is pursued, and it is shown that it is required if one demands that certain alternative off-mass-shell amplitude definitions are forced to coincide, at least to lowest order of chiral symmetry breaking. In such a dynamical scheme, which is found attractive, the κ can not at small momentum transfer dominate the vector divergence. A κ effect can, however, contribute to matrix elements in a higher order of symmetry breaking, and such a scheme is illustrated in a simple Lagrangian model. (auth)

19050 (DESY-71/62) IS THE ε(700) MESON THE GOLDSTONE BOSON OF BROKEN SCALE INVARIANCE? Renner, B.; Staunton, L. P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 15p. Dep. NTIS (U.S. Sales Only).

Low energy theorems of broken scale invariance are examined using for our tests phenomenological ($\pi\pi$) phase shifts and thus improving on the usual pole approximation for the ε(700) meson, commonly assumed to act as a Goldstone boson. Approximate consistency is found for a model based on broken $SU_3 \times SU_3$ symmetry, provided that a certain subtraction constant, already present on the level of pole models, is used as a free parameter to be fitted by the data. Yet there are definite indications that contrary to the role of the pion in broken chiral symmetry, broken scale invariance cannot be understood in terms of the ε(700) meson alone and contributions from higher states are needed in an essential manner. (auth)

19051 SU(3) x SU(3) AND DILATATION INVARIANCE OF STRONG INTERACTIONS. Haberler, P. L. F. (Duke Univ., Durham, N. C.). Lect. Theor. Phys.; 13: 303-13(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The dynamical consequences of the conformal group for hadron physics are studied. The SU(3) × SU(3) group is considered. The condition of the vanishing of all bare dimensional quantities in the framework of Lagrangian field theory is investigated using a mode field theory of mesons and baryons with pseudoscalar Yukawa coupling. An investigation is made of whether a spin-0 mass-0 particle exists in the field theory for strong interactions. (J.F.P.)

19052 A_2. Boehm, A. (Univ. of Texas, Austin). Lect. Theor. Phys.; 13: 361-76(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The A_2 algebra for the meson and baryon mass spectra is discussed. A_2 denotes an algebraic structure that is a generalization of the algebra A_1. The essential difference between A_1 and A_2 is that A_2 contains an infinite-dimensional generalization of the Dirac representation of SO(3,2), whereas A_1 contains the Majorana representation of SO(3,2) instead. (J.F.P.)

19053 BREAKING OF THE SCALE SYMMETRY AND THE DE SITTER ROTATOR. Inomata, Akira (State Univ. of New York, Albany). Lect. Theor. Phys.; 13: 377-88(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

A specific breaking scheme of the symmetry under scale transformations and its possible relation to a hadron model is treated. In this scheme the conformal symmetry reduced to the de Sitter symmetry by breaking and the de Sitter symmetry becomes the Poincare symmetry by contraction. (J.F.P.)

19054 LORENTZ INVARIANT ALGEBRAIZATION OF VERTEX FUNCTIONS. DYNAMICAL GROUP SO(3,1) × SO(4,3). Noga, Milan (Purdue Univ., Lafayette, Ind.). Lect. Theor. Phys.; 13: 389-405(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

Relations identical to the Lie algebra of the group SO(3,1) × SO(4,3) were derived by assuming isospin and Lorentz invariance, the usual equal-time commutator algebra between axial charges, absence of exotic states, and either an effective interaction Lagrangian or PCAC. It is emphasized that the dynamical calculation of the pion−hadron vertex function was reduced to a set of algebraic relations which turned out to be the same as the Lie algebra of the group SO(3,1) × SO(4,3). (J.F.P.)

19055 NONLINEAR REPRESENTATIONS OF THE POINCARE GROUP AS A POSSIBLE BASIS OF PARTICLE DYNAMICS. Hopkinson, J. F. L.; Reya, E. (Daresbury Nuclear Physics Lab., Eng.). Phys. Rev., D; 5: No. 2, 342-52(15 Jan 1972).

Nonlinear representations of the Poincaré group are studied as a possible basis for hadron dynamics. In particular it is studied whether interacting fields are, in general, equally well described by nonlinear representations of the Poincaré group as free fields are by linear representations. The fields are identified with group parameters of the appropriate group co-sets, thus forming local coordinate systems on the group manifold. On this basis possible interaction Lagrangians, expressed by invariant metrics of the co-set spaces, are derived. In contrast to the success of nonlinear representations of internal-symmetry groups (chiral groups), it is concluded that recently suggested nonlinear representations of the Poincaré group are inadequate for describing interacting fields and for deriving particle interactions, mainly because of

physically unacceptable features inherent in those representations. (auth)

19056 HARMONIC-OSCILLATOR PATTERN ARISING FROM AN ALGEBRAIC APPROACH TO CHIRAL SYMMETRY. Buccella, F. (CERN, Geneva); Savoy, C. A.; Celeghini, E. Nuovo Cim.; 7A: No. 2, 281-92(21 Jan 1972).

In a previous work a saturation scheme was proposed for the $SU_3 \otimes SU_3$ chiral algebra within an infinite set of $SU_6 \otimes O_3$ states. A mixing operator was introduced which transforms the axial charges of the SU_6 solution into the physical ones, Q_{15}. Here the Weinberg equation is saturated for the (mass)^2 operator $[Q_5^+, [Q_5^+, m^2]] = 0$, between meson states, in a perturbative approach. The generator Z of the mixing operators, for which formerly only the transformation properties under $SU_6 \times O_3$ were given, is now completely established as $Z = (W \times M)_k$, where W is the W-spin operator and M is the co-ordinate of the three-dimensional harmonic oscillator. In a perturbative expansion of the (mass)^2 operator, the lowest term consists of two pieces, the harmonic-oscillator energy and a spin-orbit coupling of the form $(-1)^{L+1}(L \cdot S + \frac{1}{2})$. The resulting (mass)^2 consists of families of equispaced linearly rising trajectories. (auth)

19057 NONLINEAR REALIZATION OF BROKEN $SU_3 \times SU_3$ FOR PSEUDOSCALAR MESONS. Guersey, F.; Serdaroglu, M. (Yale Univ., New Haven). Contract AT(30-1)-2726. Nuovo Cim.; 7A: No. 3, 584-604(1 Feb 1972).

A nonlinear realization of $SU_3 \times SU_3$ for the pseudoscalar mesons is constructed. First, the $SU_3 \times SU_3$ symmetry is broken, while keeping $SU_2 \times SU_2$ exact, by letting the K and η mesons acquire a mass. This model provides a generalization of K-π effective Lagrangians consistent with the Callan-Treiman relations. The symmetry is further broken to $SU_2 \times U_1$ by allowing the pion to have a mass. This is achieved through a one-parameter unitary transformation which has a structure similar to a generalized Cabibbo rotation. This "mass rotation" introduces a part which transforms as the "27" representation into the symmetry-breaking term. This term breaks the Gell-Mann–Okubo mode of SU_3 violation and leads to an alternative, accurate mass formula. Divergences of the currents are calculated in both broken-symmetry schemes. (auth)

19058 BROKEN CHIRAL SYMMETRY AND THE AXIAL-VECTOR-FIELD-CURRENT IDENTITY: IS THE MASSIVE PION FREE? Narayanaswamy, P. (Southern Illinois Univ., Edwardsville). Lett. Nuovo Cim.; 3: No. 6, 227-30(5 Feb 1972).

It is shown that the wave-function renormalization constant has to be necessarily unity if exact field–current identity with the canonical pion field has to be consistent with broken SU(2) × SU(2) with one-particle saturation of current commutation relations. Thus the pion is constrained to be a free field. (J.F.P.)

Field Theories

General

19059 SPACE–TIME CODE. II. Finkelstein, David (Yeshiva Univ., New York). Phys. Rev., D; 5: No. 2, 320-8(15 Jan 1972).

Quantum concepts can be applied to space-time processes to make a quantum (q) theory that is free of the possibility of divergences inherent in classical continuum theories, yet causal, Lorentz-invariant, and asymptotically Poincaré-invariant for large times. A general technique, algebraic quantization, is provided for going from classical (c) paradigms, typically discrete logical structures, to q analogs. Applied to the two-dimensional c checkerboard, algebraic quantization gives a q theory of time and space asymptotic to the four-dimensional Minkowski c theory in the limit of large time. Applied to the simplest dynamics on such a checkerboard, a piece that makes the same move again and again, algebraic quantization gives a q dynamics asymptotic to a massless spin-$\frac{1}{2}$ two-component dynamics in the same limit. The quantum of time, if it exists, must have spin $\frac{1}{2}$. Some features of general relativity such as curvature seem plausible consequences of a quantum theory of space-time processes. (auth)

19060 MODELS OF STATIC, CYLINDRICALLY SYMMETRIC SOLUTIONS OF THE EINSTEIN–MAXWELL FIELD. Safko, John L. (Univ. of South Carolina, Columbia); Witten, Louis. Phys. Rev., D; 5: No. 2, 293-300(15 Jan 1972).

Models of static, cylindrically symmetric solutions of the combined Einstein–Maxwell field equations are given. These models consist of extended distributions of matter with surface electric currents and magnetic fields outside the matter. The electric currents serve as sources of the magnetic fields; the distribution of matter as well as the magnetic fields serve as sources of the gravitational field. The magnetic lines of force may be parallel to the axis or circular and centered on the axis. The matter distribution is cylindrically symmetric and may be contained within a central cylinder or a tube centered about the axis. All ordinary physical and geometric requirements are satisfied by the models. (auth)

19061 REMARK ON THE LOCALISATION OF A CHARGED BOSE FIELD. Wilde, I. F. (Eidgenoessische Technische Hochschule, Zurich). Commun. Math. Phys.; 24: No. 1, 37-9(1971).

Two natural definitions are given for the local field algebras associated with a massive relativistic charged Bose field. These are both covariant, but are relatively antilocal in the sense of Segal and Goodman. They have the same representation of the Poincaré group, but are not in the same Borchers class. (auth)

19062 CONSTRUCTION OF FIELD EQUATIONS BY THE METHOD OF NONLINEAR GROUP REPRESENTATION. Smirnov, A. D. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 3, 346-8(May-Jun 1971). (In Russian).

The apparatus of linear representation of group symmetry is commonly utilized in contemporary field theory. Field interaction leads to nonlinear field equations. Transition to a wider group of symmetry as a rule requires the introduction of supplementary fields. The mathematical treatment proceeds to construct a nonlinear representation of groups for given fields. (K.S.W.)

19063 OSCILLATOR LEVELS OF THE PARTICLE AS A CONSEQUENCE OF STRONG INTERACTION WITH THE FIELD. Solodovnikova, E. P.; Tavkhelidze, A. N.; Khrustalev, O. A. (Inst. of High-Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 10: No. 2, 162-81(Feb 1972). (In Russian).

The motion of a particle interacting strongly with a scalar field is singled out by means of the Bogolubov transformation. The effective potential is in this case reduced to the oscillator potential. (auth)

Quantum Field Theory

Refer also to abstracts 18721, 18897, 18911, and 19141.

19064 (ITF–71–65–P) ON THE DEFINITION OF S-MATRIX IN QUANTUM FIELD THEORY. Likhachev, V. N.; Tyupkin, Yu. S.; Shvarts, A. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 52p. (In Russian). Dep. NTIS (U. S. Sales Only).

The definition is given of renormalized S-matrix in guantum field theory by means of the limit of operators simply connected with the adiabatic S-matrix. It is established that this definition is equivalent to a usual one under some conditions. (auth)

19065 (JINR–P2–6173) INVARIANT BOX METHOD IN QUANTUM THEORY OF SPINOR FIELD. Chernikov, N. A.; Shavokhina, N. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

By the example of the de Sitter spherical space-time the general principles of quantum theory of the spinor field are realized which leads to the invariant box method. (auth)

19066 POINCARE'S RENDICONTI PAPER ON RELATIVITY. PART I. Schwartz, H. M. (Univ. of Arkansas, Fayetteville). Amer. J. Phys.; 39: No. 11, 1287-94(Nov 1971).

"Sur la dynamique de l'électron," published in 1906 in Rendiconti del Circolo Matematico di Palermo, is Poincaré's principal publication dealing with relativity. It is, among other things, of very considerable historical interest. To make it more readily accessible, the contents of this comprehensive paper will be presented, in a modernized version, in three parts that correspond to the three major topics treated in the paper. The first part, presented deals with the principle of relativity and the Lorentz group as well as with the action principle of Maxwell–Lorentz systems. (auth)

19067 CROSSING-SYMMETRIC BETHE–SALPETER EQUATIONS AND THE GENERALIZED LADDER GRAPHS. Johnson, Porter W.; Yaes, Robert J. (Illinois Inst. of Tech., Chicago). Phys. Rev., D; 4: No. 12, 3766-8(15 Dec 1971).

It is shown that iteration of the crossing-symmetric Bethe-Salpeter equations with s-u crossing symmetry and t exchange will generate a subset of the generalized ladder graphs of the relativistic eikonal approximation which includes all such graphs

to sixth order. The graphs which are missing are those which are two-body irreducible in both the s and u channels. (auth)

19068 RELATIVISTIC WAVE EQUATIONS FOR PARTICLES WITH ARBITRARY SPIN. Hurley, William J. (Syracuse Univ., N. Y.). Phys. Rev., D; 4: No. 12, 3605-16(15 Dec 1971).

Relativistic wave equations are derived which generalize the recently obtained Galilei-covariant wave equations for massive particles with any integer or half-integer spin. Imposing a minimality condition on the number of components possessed by the relativistic wave function, it is shown that the index transformation properties of the wave function may be either those of the $(s,0) \oplus (s-\frac{1}{2},\frac{1}{2})$ representation of SL(2,C) or of the representation $(0,s) \oplus (\frac{1}{2},s-\frac{1}{2})$. The minimal extension of these representations which accommodates reflection symmetry yields the Dirac equation for $s = \frac{1}{2}$, the Duffin–Kemmer equation for $s = 1$, and an equation for particles with $s > 1$ whose wave-function indices transform according to the $(s,0) \oplus (s-\frac{1}{2},\frac{1}{2}) \oplus (\frac{1}{2},s-\frac{1}{2}) \oplus (0,s)$ representation of SL(2,C). The latter theory possesses $4(2s + 1)$ independent components, has no subsidiary conditions, and describes a unique mass, $m \neq 0$, and a unique spin. The theory admits a simple Lagrangian and Hamiltonian formulation and yields a conserved current. Finally, it is shown that for any spin the equation remains consistent and causal in the presence of a minimally coupled external-electromagnetic-field interaction. (auth)

19069 EIGENVALUES AND EIGENVECTORS OF THE INTERACTION TERM IN LOCAL QUANTUM FIELD THEORY. Kershaw, David S. (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 12, 3572-9(15 Dec 1971).

A basic feature of nonrelativistic quantum mechanics is the existence of one representation (the momentum representation) which diagonalizes the free part of the Hamiltonian, a second representation (the position representation) which diagonalizes the interaction part of the Hamiltonian, and a unitary transformation (Fourier transform) which connects these two representations. In local Lagrangian field theory the free-particle representation which diagonalizes the free part of the Hamiltonian is well known, but the representation which diagonalizes the interaction part of the Hamiltonian has not been systematically studied. In what follows, this representation is explicitly constructed and it is shown that there is no unitary transformation connecting it with the free-particle representation. In fact, this representation space is not even a Hilbert space, in the sense that to define a meaningful norm seems impossible. (auth)

19070 RENORMALIZED SCATTERING OPERATOR IN CLOSED FORM. I. phi^3 MODEL. Wilner, Martin (Lowell Technological Inst., Mass.). Phys. Rev., D; 4: No. 12, 3594-3604(15 Dec 1971).

A method of obtaining the results of renormalization is presented which makes no explicit reference either to perturbation theory or to the removal of infinities, but instead is based directly on physical requirements. Applied to scalar ϕ^3 theory, the method yields a closed expression for the renormalized scattering operator S in the Dyson form as an implicitly time-ordered exponential of an interaction Hamiltonian plus quasilocal counterterms. Except for the over-all phase of S, these counterterms are given as explicit functionals of the vacuum expectation value of the bilinear product of operator derivatives of S with respect to the asymptotic in-field a(x), which enables them to be calculated recursively to any given order of perturbation theory from lower orders. S is calculated in a straightforward manner up to third order of perturbation theory, and the two-point function to fourth order, and all are shown to be finite, the infinities canceling automatically. The second- and third-order results are identical with those of conventional renormalized perturbation theory. No comparable calculation of the fourth-order result seems to be available. (auth)

19071 QUANTUM CORRECTIONS TO STRESS TENSORS AND CONFORMAL INVARIANCE. Milton, Kimball A. (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 4: No. 12, 3579-93 (15 Dec 1971).

Quantum corrections to the energy-momentum tensors of particles are calculated for these theories: (1) scalar electrodynamics, (2) spinor electrodynamics, and (3) scalar particles with $\lambda\varphi^4$ self-interaction. It is shown that source theory provides a much more satisfactory approach than conventional means. The primary result of the investigation is the clear establishment of the favored role of the so-called "conformal" stress tensor—that is, the stress tensor that in the zero-mass limit transforms covariantly under the action of the conformal group. In terms of this tensor, unsubtracted spectral forms for the modifications are written down. A heuristic "proof" that this should be generally possible is provided. It is argued that broken scale invariance does not affect this subtraction-free property, and this is confirmed by explicit calculation of the order-λ^2 modifications in the $\lambda\varphi^4$ theory. (auth)

19072 CLUSTER-DECOMPOSITION PROPERTIES OF phi^3-PERTURBATION-THEORY AMPLITUDES AT HIGH ENERGY. II. Campbell, David K.; Chang, Shau-jin (Univ. of Illinois, Urbana). Phys. Rev., D; 4: No. 12, 3658-83(15 Dec 1971).

It was previously demonstrated that a cluster-decomposition technique similar to that used in statistical mechanics can be applied to the study of high-energy scattering processes. Specifically, the ladder diagrams in a φ^3 field theory are examined. In the previous analysis attention was focused on the cluster-decomposition properties of the differential multiparticle-production cross sections expressed as functions of the "momentum-transfer variables," k_i; in terms of ladder diagrams these variables correspond to the momenta carried by the sides of the ladders. Although the k-variable cluster decomposition arises naturally in theoretical analysis, a phenomenologically potentially more useful approach would apply a cluster decomposition in terms of the actual final-state particle momenta, q_i; these variables, of course, correspond to the momenta carried by the rungs of the ladder diagrams in the simple model. The validity of such a q-variable cluster decomposition in φ^3 field theories is investigated. The relationship between the k- and q-variable approaches is discussed and a number of subtleties involved in the introduction of q-variable clusters are clarified. A feature that distinguishes the q-variable analysis from the earlier k-variable analysis is that a complete cluster decomposition—that is, a decomposition in terms of all components of the momenta q_i—of the differential exclusive-production cross sections is not possible even in the simple model in which these cross sections are calculated from ladder diagrams in a φ^3 field theory in three space and one time dimensions. The q-variable cluster decomposition of the partially differential cross sections obtained by integrating over the transverse-momentum components, $q_i^\perp$ is considered. The resulting cluster decomposition, essentially in terms of the rapidities corresponding to the longitudinal components of the q_i, provides a direct and intuitive framework for theoretical calculations of inclusive multiparticle spectra and avoids the ambiguities of "particle ordering" which would have hindered application of the original k-variable clusters to phenomenological analysis. The utility of the cluster approach is illustrated in two brief model calculations of inclusive particle spectra. (auth)

19073 FERMION CONSPIRATORS AND VECTOR–SPINOR SCATTERING IN A FEYNMAN-DIAGRAM MODEL. Ahmed, M. A. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 4: No. 12, 3788-3806(15 Dec 1971).

Equal-mass vector-spinor scattering is treated in the backward direction in the context of the generalized Van Hove model. The scattering amplitude calculated with bare propagator leads to a fixed conspirator pole in the angular momentum plane. Inclusion of self-energy corrections to the spin-J fermion propagator turns the fixed pole into a moving one. A companion trajectory to the first conspirator trajectory is also found. (auth)

19074 COMMENT ON A PROOF OF THE Z = 0 CONDITION FOR COMPOSITENESS. Tirapegui, E. (Princeton Univ., N. J. Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 4: No. 12, 3807-9(15 Dec 1971).

A proof of the $Z = 0$ condition for compositeness is examined. In a previous criticism of this proof a paradoxical result was pointed out. It is proved that this result can be understood by precisely explaining the meaning of the equality of the elementary field and the Haag–Nishijima–Zimmermann field for the composite bound state. (auth)

19075 SOME REMARKS ON CONFORMAL QUANTUM FIELD THEORY AND THE MASS PROBLEM. Ingraham, R. L. (New Mexico State Univ., Las Cruces). Lect. Theor. Phys.; 13: 259-68(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The conformal invariant quantum field theory of massive particles uses tensor fields defined on the 5-dimensional manifold of "spheres" in space-time, which allows the usual T-exponential definition of the S operator. These irreducible unitary representations have continuous mass spectra, typically $(0, \infty)$. It is suggested how the "mass selection rules" given by the Feynman diagram rules might pick out certain values of the incoming and outgoing masses in a dynamics-dependent way, and thus explain the observed quasi-discrete mass spectrum. Exactly the same mathematical mechanism is responsible for avoiding causality

troubles coming from the fact that time-like and space-like intervals can be exchanged by the conformal group. (auth)

19076 RESTRICTIONS ON INELASTIC CHANNELS FROM CONFORMAL INVARIANCE. Castell, L. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Lect. Theor. Phys.; 13: 281-9(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

It is shown group-theoretically that conformal invariance restricts all final states of two incoming mass-zero particles very strongly. These results are applied to a conformal-invariant scalar field theory and to $\gamma-\gamma$ scattering, and it is concluded that there could be at most elastic scattering. A comment is given on deep inelastic electron–proton scattering. (auth)

19077 CANONICAL AND NONCANONICAL SCALE SYMMETRY BREAKING. Jackiw, R. (Massachusetts Inst. of Tech., Cambridge). Lect. Theor. Phys.; 13: 291-8(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

A study is made of scale symmetry breaking on the formal canonical level and in detailed perturbative calculations. The main result is that in perturbation theory mass terms are not the only objects which break scale symmetry. A renormalizable quantum field theory is considered. (J.F.P.)

19078 COMMUTATION RELATIONS FOR THE BROKEN CONFORMAL INVARIANCE IN QUANTUM FIELD THEORY. Cheung, F. K. (Univ. of Notre Dame, Ind.). Lect. Theor. Phys.; 13: 315-26(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

The fact that conformal symmetry is a geometric symmetry induced by space-time transformation is used in Lagrangian model field theories to define the infinitesimal generators in terms of the field operators through the Noether theorem independent of the manner in which the symmetry may be broken. Also a direct geometrical definition for the dilatation-conformal generators is considered. It is found that in all renormalizable Lagrangian models containing fields of spin 0, ½, and 1 the Noether generators and the corresponding geometrical ones are in fact equivalent. The commutation relations among these generators are obtained. It is shown that the breaking is completely determined by the divergence of the dilation current and that the broken algebra involving only the Poincare-conformal generators and the divergence of the dilatation current is model independent. A direct geometrical meaning is given to the breaking terms of the conformal invariance. (J.F.P.)

19079 GROUP THEORETICAL BASIS FOR THE DIRAC EQUATION. Mainland, G. B. (Univ. of Texas, Austin). Lect. Theor. Phys.; 13: 349-60(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

Dirac spinors, generally considered solutions to the Dirac equation, are developed from a group theoretical point of view. Commutation relations of the relativistic symmetries and the Dirac representation relation, the representation of the intrinsic part of the relativistic symmetries, the representation of the whole relativistic symmetry, and the development of the Dirac formalism are treated. (J.F.P.)

19080 TACHYONS AND QUANTUM STATISTICS. Fox, Raymond (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 5: No. 2, 329-31(15 Jan 1972).

A number of years ago, Bohm postulated the existence of a quantum potential in order to create a completely causal description of nonrelativistic quantum mechanics. It is shown that this quantum potential must be a tachyon field. An experimental test of the identification of tachyons with Bohm's quantum potential is described. It is shown though that in the above experiment space-like intervals are investigated, the information arrives after time-like intervals. The experiment thus provides an example where tachyons can affect a measured quantity though they cannot be used to violate causality. (auth)

19081 ONE-LOOP DIAGRAMS IN YANG–MILLS THEORY. Mohapatra, Rabindra Nath (Univ. of Maryland, College Park). Phys. Rev., D; 5: No. 2, 417-21(15 Jan 1972).

The problem of covariance of one-loop diagrams is discussed in a canonical formulation of Yang–Mills theory. It is shown that one-loop diagrams to all orders can be made covariant provided they satisfy certain Ward identities. Verification of these Ward identities to second order in the coupling constant shows that renormalization counterterms must be introduced into the theory. (auth)

19082 SOME ASPECTS OF FIELD SYMMETRIES. III. Scharfstein, H. Phys. Rev., D; 5: No. 2, 403-17(15 Jan 1972).

Some aspects of the connection between trilinear and bilinear equal-time commutation relations are clarified. Locality requirements satisfied by the generalized fields under discussion are examined in some detail. Using algebraic arguments it is shown that for representations of operators satisfying the generalized trilinear equal-time commutation relations either the half-integral- or the integral-spin fields or both satisfy conventional statistics. In connection with a question raised previously it is shown that the hadronic schemes considered suggest which fields should in each scheme be associated with the (hypothetical) intermediate bosons. It is shown that the discrepancy in physical content between the various particle classification schemes discussed can be substantially reduced, if not eliminated, by the introduction of a new selection rule in addition to the selection rules derived from locality and self-adjointness of the Lagrangian. The new selection rule is not unrelated to locality considerations and is also related to the metric. The question of the metric in the context of the generalized fields is briefly considered. 128 references. (auth)

19083 WIGHTMAN FORMULATION FOR THE QUANTIZATION OF THE GRAVITATIONAL FIELD. Flato, M.; Simon, J. (Royal Inst. of Tech., Stockholm). Phys. Rev., D; 5: No. 2, 332-41(15 Jan 1972).

A generalization of Wightman field theory is formulated which makes the theory also applicable to the gravitational field. Strongly geodesically complete manifolds are found to be the most suitable for description of curved space-time in our approach. After the formulation of generalized axioms, the schemes of proofs of the fundamental theorems of the theory (Bargmann–Hall–Wightman theorem, θ theorem, main reconstruction theorem, etc.) are given. Hints are given on the possible ways of constructing the theory of asymptotic states for the quantized gravitational field. (auth)

19084 NON-EXISTENCE OF GOLDSTONE BOSONS WITH NON-ZERO HELICITY. Maison, D.; Reeh, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Commun. Math. Phys.; 24: No. 1, 67-73(1971).

In a local relativistic quantum field theory a conserved covariant tensor current may lead to a spontaneously broken symmetry if it generates zero mass states from the vacuum (Goldstone theorem). It is shown that in addition it is necessary that these massless states have helicity zero if the underlaying state space has a positive metric. (auth)

19085 OPERATOR PRODUCT EXPANSIONS AND COMPOSITE FIELD OPERATORS IN THE GENERAL FRAMEWORK OF QUANTUM FIELD THEORY. Wilson, Kenneth G. (Cornell Univ., Ithaca, N. Y.); Zimmermann, Wolfhart. Commn. Math. Phys.; 24: No. 2, 87-106(1972).

The short distance behavior of field operator products is analyzed. It is shown that under certain conditions operator product expansions can be derived which give complete information on the short distance behavior and lead to the construction of composite field operators. (auth)

19086 ASYMPTOTIC BEHAVIOR OF SPIN-MOMENTUM DISTRIBUTION OBSERVABLES FOR FERMION FIELDS WITH CUT-OFF SELF-COUPLING. Prugovecki, E.; Manoukian, E. B. (Univ. of Toronto). Commn. Math. Phys.; 24: No. 2, 133-50 (1972).

In previous work asymptotic creation and annihilation operators $a_\pm^\#$ have been constructed by the Kato–Mugibayashi method from the creation and annihilation operators $a^\#$ for spin ½ fields with an interaction Hamiltonian density which is an even-degree polynomial in the field with ultra-violet cut-off and its derivatives. For any eigenvector Φ of the total Hamiltonian $H = H_0 + H_I$ partial isometries $\Omega_\pm$ have been defined so that $a_\pm^\#$ equal $\Omega_\pm a^\# \Omega_\pm^\dagger$ on the ranges $F_\pm$ of $\Omega_\pm$. Since the existence of a ground-state of H has been proved, the existence of at least one pair $\Omega_\pm$ follows. The purpose is to show that for any $\Psi \in F_\pm$ orthogonal to Φ the distribution of spins and momenta of the interacting Schrödinger states $\exp[-itH]\Omega_\pm\Psi$ approaches for $t \to \mp\infty$ the distributions of spins and momenta of the free state $\exp[-itH_0]\Psi$ if a wave-amplitude renormalization is carried out in $F_\pm$. This is achieved by studying the expectation values of the operators in the maximally abelian W*-algebra $U(\tilde{O})$ generated by operators of the form $\int \rho a^* a$, in terms of which any information about spins and momenta can be expressed. (auth)

19087 CONSTRUCTION OF CURRENTS IN A GAUGE-INVARIANT SPINOR THEORY. Duerr, H. P.; Winter, N. J. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 7A: No. 2, 461-95(21 Jan 1972).

A 2-component scale-invariant Weyl-spinor theory involving noncanonical spinor fields of dimension ½ with quartic self interaction in which the coupling constant is adjusted in such a way that—according to an earlier prescription—the theory is invariant under a phase-gage transformation (gage invariance of the second kind), is investigated. In this theory the formal "current" $:\Psi^*\sigma_\mu\Psi:(x)$ plays the role of the gage-variant vector potential. The current operators are constructed as the finite local generators of the unitary transformation in the quantum-mechanical state space corresponding to constant phase transformations of the field operators. The gage-invariant currents turn out to be of the form $\sim:\Psi^*\overleftrightarrow{\partial}_\kappa\sigma_\mu\partial^\kappa\Psi:(x)$. They are not conserved because to an Adler-type term which occurs in a definite form. This current is essentially identical to the gage-invariant current $:\Psi_c^\dagger\bar{\sigma}_\mu\Psi_c:(x)$ if the canonical field is identified as $\Psi_c \sim i\sigma^\mu\partial_\mu\Psi$. Expressions for the energy-momentum operator $T_{\mu\nu}$ and the relativistic angular momentum operators $M_{\lambda\mu\nu}$ are given and their conservation indicated. As a second step a 4-component Dirac theory with (v−a) coupling is considered which is adjusted to be invariant under chiral phase-gage transformations ($U_1 \otimes U_1$ of the second kind). This theory is intimately related to the 2-component Weyl theory. Consequently one finds that both the vector and the axial vector currents invariant under both gage transformations are not conserved. The conservation of the vector current, however, can be established by relaxing the invariance of the currents under γ_5-gage transformations whereas the conservation of the axial vector can only be arranged if the invariance under both gage transformations is given up. (auth)

19088 CALCULATION OF SUPERPROPAGATORS IN NONLINEAR QUANTUM FIELD THEORIES. Atakishiev, N. M.; Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna, USSR). Commun. Math. Phys.; 24: No. 1, 74-86(1971).

A new method of constructing the superpropagators, i.e., the Fourier transforms of the expressions of the form $\Sigma_{n=1}^{\infty} c_n\Delta_F^n(x)$ is suggested. The method makes it possible to derive by use of the same technique explicit analytic expressions for the superpropagators for a wide class of field theories—from strictly local up to essentially nonlocal. The essence of the method is the construction of a differential equation for the superpropagator which in general is of an infinite order. By use of the boundary condition at $p^2 = 0$ the solution of this equation depending on one arbitrary real parameter is found. Simple examples are given to illustrate the method. (auth)

19089 DIFFERENTIAL VERTEX OPERATIONS IN LAGRANGIAN FIELD THEORY. Lowenstein, J. H. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Commun. Math. Phys.; 24: No. 1, 1-21(1971).

A general framework is derived for studying differential operations in renormalized perturbation theory. The method makes a simple, unified derivation of the renormalization group and Callan-Symanzik equations, as well as a direct test for broken symmetries (including broken scale invariance), without the necessity of defining currents and deriving their generalized Ward identities. A second-order differential equation of the Callan-Symanzik type is derived using similar methods. (auth)

19090 EXAMPLES OF FIELDS OBEYING WRONG STATISTICS. Krolikowski, W. (CERN, Geneva). Nuovo Cim.; 7A: No. 3, 645-50(1 Feb 1972).

Examples of spin-0 and spin-½ non-Hermitian fields obeying Fermi and Bose statistics, respectively, are constructed. These fields are local and have positive energy, but they correspond to an indefinite metric, the indefiniteness of the metric being introduced into the Hilbert space by antiparticles. (auth)

19091 LAMB SHIFT AS A CONSEQUENCE OF THE FINITE SIZE OF THE ELECTRON. Lee, A. R.; Liesegang, J. (La Trobe Univ., Victoria, Australia). Lett. Nuovo Cim.; 3: No. 5, 175-8(29 Jan 1972).

It is shown conclusively that electrons with a finite radius would lead to a proper value for the Lamb shift. If the size of the electron is responsible for this phenomenon it would appear that the conventionally accepted radius would have been too small to account for the shift. (J.F.P.)

19092 DEGREES OF SYMMETRY IN QUANTUM FIELD THEORIES. Maris, Th. A. J.; Dillenburg, D.; Jacob, G.; Liberman, B. (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). Nucl. Phys.; B37: No. 2, 444-60(1972).

A hierarchy of possible symmetries in quantum field theory is defined, which reaches from a purely mathematical invariance to the conventional physical invariance, including the commonly discussed type of spontaneously broken symmetry (SBS). It is shown that one type of SBS, which is usually not considered, naturally leads to theories with an algebra of nonconserved currents and a nonlinearly transforming phenomenological Lagrangian. An exactly solvable model is given and some general remarks are made. (auth)

19093 REST FRAMES IN RELATIVISTIC THERMODYNAMICS. Horwitz, G. (Hebrew Univ., Jerusalem). Phys. Rev., D; 4: No. 12, 3812-13(15 Dec 1971).

Includes reply by Victor H. Hamity.

Stress is put on the fact that there are instances in which the association of a rest frame with a given equilibrium thermal distribution may be meaningless in a relativistic thermodynamics with the usual definitions of a thermodynamic system and thermodynamic equilibrium. (auth)

19094 POSSIBLE EXPERIMENTAL VERIFICATION OF CONSTANCY OF THE VELOCITY OF LIGHT. Karastoyanov, A. S. (Higher Inst. for Mechanical and Electrical Engineering, Sofia). Phys. Lett.; 38A: No. 4, 289-90(14 Feb 1972).

The feasibility of an experiment for the measurement of the velocity of light in vacuum after Compton scattering on fast electrons is pointed out. (auth)

19095 RENORMALIZATION AND PHASE TRANSITIONS. Moore, M. A. (Univ. of Sussex, Brighton, Eng.). Lett. Nuovo Cim.; 3: No. 7, 275-80(12 Feb 1972).

The relation between quantum field theory and the statistical mechanics of second-order phase transitions is illustrated for the case of scalar $\lambda_0\phi^4$ theory. It is also pointed out that if the universality hypothesis of critical behavior is valid then a consequence would be that the renormalized coupling constant λ of the field theory would be uniquely determined. A method of calculating this unique value of λ, based upon the use of high-temperature series expansions, is briefly outlined. The treatment of the renormalization problem is not restricted to the $\lambda_0\phi^4$ theory; it can be extended to such model field theories as the σ-model in both its linear and its nonlinear versions. (L.B.S.)

19096 GAUGE INVARIANCE AND MASS SCALE. Saller, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 7A: No. 4, 779-96(21 Feb 1972).

The self-consistency problem for a spinor field ψ of mass dimension ½ is considered in a theory with a scale-invariant nonlinear spinor equation. It proves possible by the requirement of gauge invariance to maintain dim ψ = ½ also in a theory of interacting fields. The introduction of scale invariance breaking by massive poles into the fermion propagator makes it possible to obtain nontrivial boson solutions, especially zero-mass spin-1 bosons connected with gauge invariance of the theory. These gauge bosons couple directly only to that part of the fermion propagator which does not contain massless fermions. (auth)

19097 TENSOR FORMULATION OF SPIN-1 AND SPIN-2 FIELDS. Macfarlane, A. J.; Tait, W. (Cambridge Univ., Eng.). Commun. Math. Phys.; 24: No. 3, 211-24(1972).

Spin projection operators which constitute a resolution of the identity in the space of second rank tensor wave functions are constructed. These projectors are then used to establish Lagrangian quantum field theories for free massive particles with spin-1 (two equivalent formulations) and spin-2. (auth)

19098 APPROXIMATE VACUUMS IN $(:\phi^{2m}:g(x))_2$ FIELD THEORIES AND PERTURBATION SERIES. McClary, W. K. (Univ. of Toronto). Commun. Math. Phys.; 24: No. 3, 171-9 (1972).

A class of perturbation problems is considered, in which the Rayleigh–Schroedinger perturbation series for the ground state eigenvalue and eigenvector are presumed to diverge. This class includes the $(:\phi^{2m}:g(x))_2$, (m = 2,3) quantum field theory models and the quantum mechanical anharmonic oscillator. It is shown that, using matrix elements and vectors which occur in the series coefficients, one may construct convergent approximants to the eigenvalue and eigenvector. Results of a calculation of the ground state energy of the x^4 anharmonic oscillator are given. (auth)

19099 FUNCTIONAL QUANTUM THEORY OF SCATTERING PROCESSES. IV. Stumpf, H. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 26a: No. 10, 1730-9(Oct 1971).

Dynamics of quantum field theory can be formulated by functional equations. To develop a complete functional quantum theory the physical information has to be given by functional operations

only. The most important physical information of elementary particle physics is the S-matrix. The functional S-matrix is constructed for the scattering of relativistic dressed particles, i.e., for particles with structural properties. The basic functional equation is assumed to be derived from a nonlinear spinor field equation with noncanonical relativistic Heisenberg quantization. The initial free dressed many-particle states are defined, and the scattering functionals are constructed. By the use of irreducible representations the equivalence of the functional S-matrix with the conventional Hilbert space definition is shown with respect to an appropriate definition of the functional scalar product. Technical details are discussed. (auth)

19100 FUNCTIONAL QUANTUM THEORY OF SCATTERING PROCESSES. III. Stumpf, H.; Engeser, W.; Illig, K. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 26a: No. 10, 1723-9(Oct 1971).

Dynamics of quantum field theory can be formulated by functional equations. To develop a complete functional quantum theory one has to describe the physical information by functional operations only. The most important physical information of elementary particle physics is the S-matrix. The functional S-matrix is constructed for nonrelativistic spin ½ fermions, as in this system a rigorous construction of operator representations is possible. The method of S-matrix derivation used in I and II is improved and the exact perturbation solution for the scattering functionals is given. (auth)

19101 WARD IDENTITIES IN GAUGE THEORIES. Slavnov, A. A. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 10: No. 2, 153-61(Feb 1972). (In Russian).

The generalized Ward–Takahashi identities are obtained for the gauge theories of the type of the massless Yang–Mills field. It is shown that all the divergences of the Yang–Mills theory can be removed by means of the renormalization of the charge and the wave function. (auth)

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Refer also to abstracts 17873, 18534, 18610, 18617, 18618, and 18934.

19102 FINITE REST MASSES OF WAVE QUANTA IN MATERIAL MEDIA. Cole, K. D. (La Trobe Univ., Bundoora, Australia). Aust. J. Phys.; 24: No. 6, 871-80(Dec 1971).

The equivalence of a dispersion relation and Einstein's mass–energy relation leads to the specification of a particle in a vacuum which is equivalent to a "photon" in a medium. The invariance of the rest mass of this particle leads to a formula for the Doppler effect which is good for all forms of waves whose quanta can be described by $E = \hbar\omega$ and $p = \hbar k$. Applying dynamical equations to the equivalent particle in the case of a radiofrequency photon in a plasma around a star, a new gravitational redshift formula is deduced which reduces to the well-known expression in the appropriate limit. A new form of bending of photon trajectories in a gravitational field is also described. At frequencies near the plasma frequency ν_p the bending is $\nu_p/4(\nu - \nu_p)$ times that for light in a vacuum. (auth)

19103 TRANSFORMATIONAL PROPERTIES OF DYNAMICAL CHARACTERISTICS OF VECTOR FIELDS. Raigorodskii, L. D. (Leningrad Shipbuilding Inst.). Phys. Lett.; 37A: No. 4, 273(6 Dec 1971).

It is shown that Lorentzian equations of motion of test particles in a vector field are invariant under the special transformations of dynamical characteristics of this field. (auth)

19104 RESTRICTIONS FROM GEOMETRY ON QUANTIZATION IN CURVED SPACE–TIME. Flato, Moshe; Simon, Jacques; Sternheimer, Daniel (Royal Inst. of Tech., Stockholm). Phys. Rev. Lett.; 28: No. 6, 385-7(7 Feb 1972).

The relations between the quantized gravitational field and its curved space–time background are studied. Some restrictions on the geometrical quantization of the gravitational field are then deduced in the framework of axiomatic field theory. This shows the necessity of the introduction of the formalism developed earlier. (auth)

19105 ELECTROMAGNETIC THIRRING PROBLEM. Ehlers, J. (Univ. of Texas, Austin); Rindler, W. Phys. Rev., D; 4: No. 12, 3543-52(15 Dec 1971).

A neutral rotating mass shell surrounds a concentric stationary electrically charged insulating shell. The dipole-like magnetic field induced by (and proportional to) the rotation of the neutral shell is calculated on the basis of the coupled linearized Einstein–Maxwell field equations of general relativity. This field is apparently at variance with a conjecture made on Machian grounds, for which a possible explanation is suggested. The corresponding induced quadrupolar electric field is calculated for the region within the charged shell, and the potential is given for this field everywhere. Though understandable on mutually inconsistent elementary grounds, this field is regarded as a useful example of a solution of linearized general relativity. (auth)

19106 MOTION OF PARTICLES IN EINSTEIN'S RELATIVISTIC FIELD THEORY. III. COORDINATE CONDITIONS. Johnson, Coates R. (Univ. of Georgia, Athens). Phys. Rev., D; 4: No. 12, 3555-8(15 Dec 1971).

In two earlier papers an approximation procedure was developed for finding the Lorentz-covariant equations of structure and motion of interacting particles (represented by singularities) in Einstein's theory of the nonsymmetric field and in Einstein's theory of the gravitational field. Work was done exclusively in a specific set of coordinate systems, the harmonic coordinate systems. It is shown that the procedure developed in the earlier papers can be used without imposing any conditions on the coordinates except that the fundamental field be the Minkowski metric in the absence of particles. It is also shown that up to any finite order of approximation the use of harmonic coordinates does not reduce the set of invariantly distinct solutions to Einstein's field equations. (auth)

19107 NEW IMPROVED ENERGY MOMENTUM TENSOR. Jackiw, R. (Massachusetts Inst. of Tech., Cambridge). Lect. Theor. Phys.; 13: 299-302(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

It is shown that for any renormalizable field theory it is possible to find an energy-momentum tensor whose matrix elements are finite. It is noted that this object is not always the conventional Belinfante tensor, although the total energy and angular momentum remain unchanged. (J.F.P.)

19108 DOES THE ENERGY–MOMENTUM TENSOR REALLY NEED TO BE IMPROVED. Hagen, C. R. (Univ. of Rochester, N. Y.). Phys. Rev., D; 5: No. 2, 389-94(15 Jan 1972).

The question whether the canonical form of the energy-momentum tensor should be abandoned in favor of one recently proposed by Callan, Coleman, and Jackiw is considered by adopting the criterion that any such modification must not be motivated entirely by the specific framework and properties of special relativity. Thus the possibility of divorcing the issue of the finiteness of the matrix elements of these operators from a specific relativity group is examined in the Galilean or nonrelativistic limit. It is found that for the case of a scale-invariant spin-zero Galilean theory in four spatial dimensions, the matrix elements of neither the canonical nor the "improved" energy-momentum tensor are finite. This circumstance may be seen to be a consequence of an increase in the number of independent form factors required in the nonrelativistic domain. Inasmuch as there is no possibility of making finite the matrix elements of the energy-momentum tensor in the Galilean limit by a redefinition, it is suggested that the quite different situation which one encounters in special relativity is largely accidental and that there is consequently no compelling argument for a modification of the gravitational interaction. (auth)

19109 MOTION OF PARTICLES IN EINSTEIN'S RELATIVISTIC FIELD THEORY. IV. DIFFUSE AND LOCALIZED ELECTRIC CHARGE. Johnson, Coates R. (Univ. of Georgia, Athens). Phys. Rev., D; 5: No. 2, 282-4(15 Jan 1972).

In several earlier papers an approximation method was developed for finding the Lorentz-covariant equations of structure and motion of interacting particles represented by singularities in Einstein's theory of the nonsymmetric field. It is shown that two of the quantities which describe the structure of such particles—the coefficient of diffuse electric charge and the localized electric charge—can be considered, with no loss in generality, as time-independent to all orders of approximation. (auth)

19110 SCALAR–TENSOR THEORY OF GRAVITATION. Ross, D. K. (Iowa State Univ., Ames). Phys. Rev., D; 5: No. 2, 284-90(15 Jan 1972).

A scalar-tensor theory of gravitation is constructed using the Weyl formulation of Riemannian geometry. The scalar field is given an important geometrical role to play and is related to the integrable change in length of a vector as it is transported from point to point in space-time. The geometry uses modified covariant derivatives and a metric tensor which is not covariantly constant. The field equations can be written down very simply in terms of a modified curvature tensor. The theory agrees with

the usual Lagrangian formalism in its experimental predictions and offers a reformulation or reinterpretation of the transformation of units considered by Dicke. (auth)

19111 REDUNDANCY OF CONSTRAINTS IN THE CLASSICAL AND QUANTUM THEORIES OF GRAVITATION. Moncrief, Vincent (Univ. of Maryland, College Park). Phys. Rev., D; 5: No. 2, 277-81(15 Jan 1972).

It is shown that in Dirac's version of the quantum theory of gravitation, the Hamiltonian constraints are greatly redundant. If the Hamiltonian constraint condition is satisfied at one point of the underlying, closed three-dimensional manifold, then it is automatically satisfied at every point, provided only that the momentum constraints are everywhere satisfied. This permits one to replace the usual infinity of Hamiltonian constraints by a single condition which may be taken in the form of an integral over the manifold. Analogous theorems are given for the classical Einstein–Hamilton–Jacobi equations. (auth)

19112 GRAVITATIONAL LAGRANGIAN. Carmeli, Moshe; Fickler, Stuart I. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., D; 5: No. 2, 290-3(15 Jan 1972).

The method of recasting the Newman–Penrose formalism for the gravitational field equations into a Yang–Mills-type theory is reviewed. The free-field gravitational Lagrangian density structured along the lines of the free-field Yang–Mills Lagrangian density by Kibble is generalized to give the complete set of gravitational field equations one obtains in the Newman–Penrose formalism. (auth)

19113 VACUUM-FIELD SOLUTIONS IN THE BRANS–DICKE THEORY. O'Hanlon, J.; Tupper, B. O. J. (Univ. of New Brunswick, Fredericton). Nuovo Cim.; 7B: No. 2, 305-12 (11 Feb 1972).

The field equations of the Brans-Dicke theory are solved for a vacuum with the aid of a space-time metric of Friedmann type. Nonstatic solutions are found showing that, in general, a Birkhoff theorem does not exist for the Brans-Dicke theory. Solutions are also found which may be interpreted as being contrary to Mach's principle. (auth)

19114 MASS-ZERO SPIN-TWO FIELD AND GRAVITATIONAL THEORY. Coulter, C. A. (Clark Univ., Worcester, Mass.). Nuovo Cim.; 7B: No. 2, 284-304(11 Feb 1972).

It is shown that the conventional theory of the mass-zero spin-two field with sources introduces extraneous nonspin-two field components in source regions and fails to be covariant under the full or restricted conformal group. A modified theory is given, expressed in terms of the physical components of the mass-zero spin-two field rather than in terms of "potentials," which has no extraneous components inside or outside sources and which is covariant under the full conformal group. For a proper choice of source term, this modified theory has the correct Newtonian limit and automatically implies that a symmetric second-rank source tensor has zero divergence. The development given suggests that the weak-field limit of general relativity is not a satisfactory spin-two theory in the interior of sources, but it is shown that possibly a generally covariant form of the spin-two theory derived here can be constructed to agree with general relativity in all currently accessible experimental situations. The completion of the theory of the interacting mass-zero spin-two field and a construction of its generally covariant form will require the identification of a suitable potential for the field, a problem which has not yet been solved. (auth)

19115 EVENT HORIZONS IN STATIC SPACE–TIMES. Ludwig, Garry (Univ. of Alberta, Edmonton). Commun. Math. Phys.; 23: No. 4, 255-61(1971).

A proof of the (vacuum) Israel theorem on event horizons in static space-times is given employing the Newman-Penrose formalism. The theorem is extended to include the case of a static, massive, complex, scalar field. (auth)

19116 FREE ENERGY OF GRAVITATING FERMIONS. Hertel, P.; Thirring, W. (CERN, Geneva). Commun. Math. Phys.; 24: No. 1, 22-36(1971).

In a suitable thermodynamic limit, the free energy of a system of nonrelativistic fermions which interact with attractive r^{-1}-potentials is calculated rigorously. It is shown that the effective field approximation becomes exact in this limit and results in the temperature-dependent Thomas-Fermi equations. (auth)

19117 SELF-INTERACTION OF GRAVITATIONAL FIELDS OF RAPIDLY MOVING POLE–DIPOLE SOURCES. Bennewitz, F.; Westpfahl, K. (Univ., Freiburg i. B.). Commun. Math. Phys.; 23: No. 4, 296-318(1971). (In German).

Retarded solutions of the second order Lorentz-covariant approximation of Einstein's field equations for rapidly moving pole-dipole-like mass distributions are constructed. As the conventional Green's function method breaks down here, the integration is accomplished by a new regularization procedure based on analytic continuation of properly cut integrals. It is pointed out that there is no self-interaction for a pole-particle, in contradistinction to a spin-particle, where the self-interaction manifests itself in a back-scattering of gravitational radiation (producing a wave tail). (auth)

19118 ABSENCE OF GRAVITATIONAL SCINTILLATION. Bertotti, B.; Trevese, D. (European Space Research Inst., Frascati, Italy. European Space Research Organization, Frascati, Italy). Nuovo Cim.; 7B: No. 2, 240-6(11 Feb 1972).

The effect of gravitational waves on electromagnetic propagation was studied in the physical optics approximation; it was found that, owing to the transversal character of the former, this effect has a local character (i.e., it does not increase with the distance traveled). Nonlocal perturbations might occur if the gravitational waves had a longitudinal component, but even in this case the effect is negligible, due to the fact that both fields propagate with the same speed. (auth)

19119 ELECTRIC FIELDS INDUCED BY GRAVITATIONAL FIELDS IN METALS. Leung, M. C. (Univ. of Saskatchewan, Regina). Nuovo Cim.; 7B: No. 2, 220-4(11 Feb 1972).

With the aid of Boltzmann's transport equation, the electric fields, induced inside a metal by the earth's gravitational field, by the Thirring field and by rotation, are calculated. (auth)

19120 DISPERSION AND ATTENUATION OF LIGHT BY A WEAK RANDOM GRAVITATIONAL-WAVEFIELD BACKGROUND. Bourret, R. (Observatoire de Paris, Meudon, France). Nuovo Cim.; 7B: No. 2, 195-219(11 Feb 1972).

The effect of a random gravitational-wave metric upon the mean value of an electromagnetic wave is calculated and discussed. Dispersion and attenuation are induced by the random metrical wave field, but their magnitude, as found by using current estimates of likely gravitational wave sources, is found to be far below the limits of observability. A more fundamental approach based upon gravitational turbulence theory is suggested. (auth)

19121 STEADY-STATE DISTRIBUTIONS IN COVARIANT STATISTICS. Podosenov, P. B. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 3, 292-7(May-Jun 1971). (In Russian).

The covariant statistical equation of continuity is considered for some concrete metrics in the general theory of relativity. An exponential velocity distribution of particles as a solution to the continuity equation resides in the metrics of Schwartzschild and in the generalized metrics of Friedman. In the uniformly rotating system there also exists an exponential velocity distribution of particles. (tr-auth)

19122 EQUATION OF PARTICLES WITH SPIN ½. Lenoir, Marcel (Univ., Clermont-Ferrand, France). Compt. Rend., Ser. A; 273: No. 20, 943-6(15 Nov 1971). (In French).

A variational principle for the field equations of spin ½ particle in a space-time having a non-Riemann Euclidean connection is stated. The energy-momentum tensor is defined. (France)

19123 COMMENT ON COLEMAN'S THEORY OF GRAVITATION. Harvey, A. L. (Queens Coll., New York). J. Phys., A (London); 5: No. 2, L30-1(Feb 1972).

The similarity of Coleman's 1971 J. Phys. A: Gen. Phys. 4: 611 theory to a special case of a class of theories presented by Papapetrou 1954 is discussed. (auth)

19124 NOTE ON LORENTZ-COVARIANT THEORIES OF GRAVITATION. Basano, L. (Univ., Genoa). J. Phys., A (London); 5: No. 2, L28-9(Feb 1972).

The most recent Lorentz-covariant theory of gravitation is considered. It is shown how this theory could be easily deduced from Einstein's general relativity, so that agreement with the three celebrated tests follows as a trivial consequence, without need for calculations. (auth)

19125 EXTERNAL FIELD OF A NONSTATIC ISOLATED SYSTEM IN BONNOR'S UNIFIED FIELD THEORY. Pant, D. N. (Banaras Hindu Univ., India). J. Phys., A (London); 5: No. 2, L25-7(Feb 1972).

The field equations of Bonnor's 1954 Proc. R. Soc. A 226 366 unified field theory were considered to obtain the external field of a general nonstatic spherically symmetric isolated system containing electric and magnetic charges associated with matter. It

was found that there exists only one nontrivial solution and it represents a static isolated magnetic monopole. (auth)

19126 LOSS OF GRAVITATIONAL MASS OF A ROTATING ROD AS OUTGOING GRAVITATIONAL RADIATION. Rotenberg, M. A. (Univ. of Wisconsin, Kenosha). J. Phys., A (London); 5: No. 2, 198-210(Feb 1972).

The solution of the gravitational field equations of general relativity is obtained for the metric field of a rotating rod. A Schwarzschildian correction term is found that represents a steady diminution of mass of the rod on account of the gravitational waves emitted. (auth)

19127 TWO-BODY PROBLEM IN THE THEORY OF GRAVITATION WITHOUT POTENTIAL. Oja, H. (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI; No. 377, 1-40(1971).

Thesis.

The theory of gravitation without potential is based on eight axioms. The force law deduced from the axioms contains, in the form treated, eight structure constants, three of which have been determined in connection with the one-body problem. The value of one more constant is obtained from the results concerning the two-body problem. The theory does not assume constancy of masses. In the two-body problem the masses are found to change periodically. The perturbations caused by this change are of the same type as those due to the other terms in the equation of relative motion, i.e., advance of periastron, acceleration of the center of mass and dilatation of the sidereal period. (auth) (FINLAND)

19128 GEODESICS OF CERTAIN SYMMETRIC SPACES. Sebestyen, A. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 3, 305-20(1971).

Geodesics of Riemannian spaces admitting certain types of Killing's motions are considered. It is shown that corresponding to the geodesics there are curves in a lower-dimensional space which reveal a striking resemblance to the force laws of general relativity. The forces which emerge are of the electromagnetic and of the potential type. Some connections with KA. A's five-dimensional theory are discussed. The so-called totally covariant calculus for such spaces is also developed. (auth)

19129 CRITERIA OF SPACE HOMOGENEITY IN GENERAL RELATIVITY THEORY. Grishchuk, L. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 19: No. 12, 1129-33(1971).

At present two criteria of the space homogeneity are widely used in general relativity. It is shown that each of them can be obtained as a generalization of the equivalent definitions of homogeneity in the flat space. An example of metric is given which emphasizes the main difference between those criteria. (auth)

Scattering Theory

Refer also to abstracts 18861, 19029, 19099, and 19100.

19130 (DNPL/R-17) REGGE THEORY FOR EXPERIMENTALISTS. Lecture Note Series No. 6. Storrow, J. K. (Daresbury Nuclear Physics Lab. (England)). 1971. 66p. Dep. NTIS (U. S. Sales Only).

These notes are based on lectures given at Daresbury Nuclear Physics Laboratory, 21 to 25 June 1971 and are presented under the headings; basic S-matrix theory (kinematics, crossing and analyticity), Regge poles (motivation, complex angular momentum, connection with particles, signature, simple features), simple models for cuts (cuts in the J-plane, a Regge cut as the exchange of two Regge poles, the Reggeised absorption model, the Reggeised eikonal model, geometrical picture), spin (helicity formalism, spin effects in Regge theory), duality (finite energy sum rules, two component duality and exchange degeneracy, further aspects of exchange degeneracy, duality diagrams), phenomenological applications (poles and cuts, pion-nucleon scattering). 47 references. (UK)

19131 (ITF-71-97-E) EXPANSION OF THE SCATTERING AMPLITUDE WITH THE REPRESENTATIONS OF THE GROUP 0(3,C) USED. Kirshbaum, D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 36p. Dep. NTIS (U. S. Sales Only).

Using the group 0(3,C), an expansion of the scattering amplitude for the two-particle scattering process (equal mass case without spins) is given. This expansion holds for the whole complex Mandelstam plane, the three channels are related to definite subgroups of 0(3,C). From the well-known properties of the representation functions of 0(3,C) and its subgroups some relations for the scattering function are obtained. (auth)

19132 (JUL-793-FF) INVERSE PROBLEMS IN CLASSICAL POTENTIAL SCATTERING. Dettmann, K.; Schroeder, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerperforschung). Sep 1971. 60p. (In German). Dep. NTIS (U. S. Sales Only).

Three methods of classical theory are presented. The semiclassical method was described with the help of the W.K.B. method. On the basis of a connection in the forward direction, the inverse problem was solved by means of a perturbation calculation. Examples with $V(r) \sim 1/r, 1/r^2$ were calculated for all these methods. (J.S.R.)

19133 (KFKI-71-60) EXPANSIONS OF THE UNEQUAL-MASS SCATTERING AMPLITUDE IN TERMS OF PONICARE REPRESENTATIONS AND COMPLEX ANGULAR MOMENTUM AT ZERO ENERGY. Szego, K.; Toth, K. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 28p. Dep. NTIS (U. S. Sales Only).

The expansion of the unequal-mass scattering amplitude in terms of Poincaré-group representations was considered for positive and zero values of s, the squared total four-momentum. The usual singularity problem at $s = 0$ was avoidable, but it turned out, that the relevant variable is not j, the total angular momentum, but a quantity nonsingularly related to the Poincaré-invariant $W_\mu W^\mu$ even at $s = 0$. The notion of complex angular momentum and signature was reexamined, and some modification of the old formalism seemed useful. The results are perfectly compatible with dispersion relations and with the requirements of Regge behavior. A theorem is proved for the expansion of a class of not square-integrable, but Regge behaved functions with respect to unitary E(2) representations/that is, for Fourier-Bessel expansions/. (auth)

19134 (NYO-3829-87) OPERATOR FORMULATION OF A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Coon, Darryl D. (Pittsburgh Univ., Pa.); Yu, S.; Baker, M. (Washington Univ., Seattle). Jan 1972. Contracts AT(45-1)-1388B; AT(30-1)-3829. 17p. Dep. NTIS.

An operator formalism for a dual resonance theory with nonlinear trajectories is presented, and an explicit, factorized operator representation is obtained for the N point function. Operator Ward identities are also given. (auth)

19135 SHADOW CHANNELS IN POTENTIAL THEORY. Moore, R. J. (Univ. of Texs, Austin). Phys. Rev., D; 4: No. 12, 3755-9(15 Dec 1971).

The effect of coupling a shadow channel to a real channel is studied in the framework of nonrelativistic potential-scattering theory. For simplicity, s-wave scattering with energy-independent δ-function potentials is considered. This model has the virtue of being exactly solvable in configuration space. The main features of the solution, which are analogous to those expected in a relativistic field theory whose divergences have been removed using Sudarshan's shadow states, are as follows. The coupled problem reduces in the real channel to scattering by an effective energy-dependent pseudopotential. The physical scattering amplitude still satisfies elastic unitarity at all energies, but is piecewise analytic, with a point of nonanalyticity occurring at the threshold for the shadow channel. (auth)

19136 NOTE ON THE EQUIVALENCE OF REGGE AND GEOMETRIC MODELS. Hendry, Archibald W. (Indiana Univ., Bloomington). Phys. Rev., D; 5: No. 1, 215-19(1 Jan 1972).

It is shown that a Regge pole plus destructive cut imitates a direct-channel Regge pole, the interpretation of which is well known in classical scattering theory. The rotating Regge part is "dual" to scattering from the edge of an interaction region of radius 0.8 F. A new interpretation is given for Schmid loops. (auth)

19137 REGGE BEHAVIOR, CROSSING SYMMETRY, AND UNITARITY IN THE NAKANISHI REPRESENTATION. Taha, M. O. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 4: No. 12, 3768-76(15 Dec 1971).

The analyticity of the weight function ψ in the Nakanishi representation is discussed under certain assumptions and a simple inversion formula is proved. Two-particle unitarity is formulated as an integral equation for ψ. A crossing-symmetric asymptotic form for ψ corresponding to Regge behavior for the amplitude is obtained. The significance of this investigation for the construction of dual amplitudes is discussed. (auth)

19138 TWO-VARIABLE EXPANSIONS BASED ON THE LORENTZ AND CONFORMAL GROUPS. Winternitz, P.

(Carnegie-Mellon Univ., Pittsburgh). Lect. Theor. Phys.; 13: 231-52(1971).

From De Sitter and conformal groups and their applications conference; Boulder, Colo. (29 Jun 1970).

A review is given of a scattering theory based on two-variable expansions furnished by the Lorentz group. Arguments are given for using the conformal group in such a program, in order to make as much use as possible of relativistic invariance and crossing symmetry simultaneously. (auth)

19139 K MATRIX FOR THREE-PARTICLE SCATTERING. Kowalski, K. L. (Case Western Reserve Univ., Cleveland). Phys. Rev., D; 5: No. 2, 395-403(15 Jan 1972).

The realization of the three-body K-matrix formalism in terms of Faddeev-type scattering integral equations is established. A prescription is suggested for handling possible resonance-pole singularities in the two-particle K matrices which enter as input into these equations. As an application of the formalism a fully unitary impulse approximation is developed. (auth)

19140 ALGEBRAIC REDUCTION OF FADDEEV EQUATIONS. Kukulin, V. I. (Moscow State Univ.). Yadern. Fiz.; 14: No. 4, 862-73(Oct 1971). (In Russian).

The consecutive and total reduction of the Faddeev equations is proposed based on the consecutive approximation of integral kernels by the finite rank operators both in the two- and three-body problems. As an illustration, a convenient basis for the Gauss potentials is given and some concrete samples for separable potentials are considered. Some new properties of three-particle excited states are discussed. (auth)

19141 WICK FLIP IN TERMS OF THE BETHE–SALPETER EQUATION. Dunaevskii, A. M.; Roizen, I. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 14: No. 4, 855-61(Oct 1971). (In Russian).

It is shown that the existence of the Bethe–Salpeter equation for the amplitude which is a unified analytical function describing the scattering in three coupled channels, leads to the possibility of "combined Wick flip." The latter is the following consequence of operations: the usual Wick flip in the physical region of the t-channel, analytical continuation into the physical region of the s-channel and the usual Wick flip in this region. (auth)

19142 OFF-ENERGY-SHELL PHASE SHIFTS IN POTENTIAL SCATTERING. Kelly, R. L. (Carnegie-Mellon Univ., Pittsburgh). Nuovo Cim.; 7A: No. 2, 321-9(21 Jan 1972).

A method for calculating off-energy-shell partial-wave amplitudes in potential scattering is presented. The method is analogous to the procedure of extracting a phase shift from the asymptotic form of a wave function, and avoids the use of integral equations. The usual on-shell procedure is generalized by introducing the idea of an off-energy-shell phase shift. Both the off-shell T-matrix and the off-shell K-matrix can be calculated in this way. It is shown that the slope of a resonance form factor is simply related to the derivative of the off-shell phase shift at the resonance. (auth)

19143 ASYMPTOTIC BEHAVIOR OF THE DUAL POMERON AMPLITUDE. Alessandrini, V. (CERN, Geneva. Univ., Geneva); Amati, D.; Morel, B. Nuovo Cim.; 7A: No. 4, 797-823 (21 Feb 1972).

A rigorous derivation is given of the asymptotic properties of the one-loop nonplanar amplitude. Both s- and t-channel asymptotic behaviors are investigated. They are controlled by the expected Regge singularities and possible exponentials are ruled out. The s-channel fixed-angle behavior is again an exponential. The coefficient of s in the exponential is exactly half of that obtained for the Born approximatic and the planar loop. (auth)

19144 EXACT SOLUTION OF THE SCHROEDINGER EQUATION WITH A CENTRAL POTENTIAL. Kanellopoulos, E. J.; Kanellopoulos, Th. V.; Wildermuth, K. (Univ., Tuebingen, Ger.). Commun. Math. Phys.; 24: No. 3, 233-42(1972).

The exact solution of the Schrödinger equation is derived for the case of a central potential under rather weak restriction on it. The solution is given in a form of a simple series which converges strongly and it is suitable for calculation of phase shifts and eigenvalues. Also, as the derivation of the solution is purely algebraic its analytical continuation in the energy or angular momentum complex plane is straightforward. (auth)

19145 HIGH ENERGY SCATTERING. III. Low, F. E. Comments Nucl. Particle Phys.; 5: No. 1, 12-15(Jan-Feb 1972).

Three models are discussed that attempt to explain why the leading singularity in the J plane appears to be located so near the point J = 1, and hence can account for the near constancy of high energy cross sections. These models may be referred to as (i) the bootstrapped Regge pole theory (Phys. Lett. B.31: 75(1970)), (ii) the bootstrapped Regge cut theory (Phys. Rev. 167: 1342(1968)), and (iii) the vector field theory (Phys. Rev. Lett. 24: 1456(1970)). 7 references. (UK)

19146 DUAL REPRESENTATION FOR NONPOMERON REGGE CUTS. Joshi, G. C. (Univ. of Melbourne, Parkville, Australia). Lett. Nuovo Cim.; 3: No. 6, 243-7(5 Feb 1972).

The high-energy behavior of a dual representation for the scattering amplitude in terms of Regge cuts is discussed. (J.F.P.)

19147 CONSERVED CURRENTS AND SYMMETRY TRANSFORMATIONS IN LOCAL SCATTERING THEORY. Kraus, K. (Univ., Marburg, Ger.); Landau, L. J. Commun. Math. Phys.; 24: No. 3, 243-52(1972).

The relation between conserved currents and symmetries of the S-matrix is investigated within the framework of Wightman field theory. Assuming a complete particle interpretation with no massless particles, it is shown that every conserved current yields a self-adjoint charge operator which acts additively on n-particle states and commutes with the S-matrix. For currents satisfying current algebra relations of a group G, the corresponding charges generate a unitary representation of G. (auth)

19148 EFFECT OF STRONG REPULSION OF COMPOUND PARTICLES (NUCLEI, ATOMS) AT SHORT DISTANCES. Baz, A. I. JETP Lett. (USSR) (Engl. Transl.); 14: No. 11, 423-6 (5 Dec 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 11, 607-10(5 Dec 1971).

The collision of two compound particles consisting of identical fermions (two atoms or nuclei) is considered. The Pauli principle should lead to a strong repulsion between the particles at short distances. The repulsion sets in at distances between particles such that their wave functions begin to overlap. A quantum-mechanical theory of this effect is developed, and it is shown that two particles made up of fermions of one type will always repel each other as soon as the distance between them becomes smaller than their total radius. At collision energies that are not too high, the particles will not be able to penetrate into each other at all. This phenomenon has been known for a long time in atomic physics; an analogous phenomenon should be observed in the scattering of particles by each other in nuclear physics. (R.W.R.)

19149 FUNCTIONAL INTEGRATION AND THE REGGE-EIKONAL REPRESENTATION. Barbashov, B. M.; Nesterenko, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 10: No. 2, 196-203(Feb 1972). (In Russian).

The Regge-eikonal representation for the scattering amplitude of the high-energy particles is deduced in the $g\psi^2\varphi$ scalar model by the method of functional integration in the straight-line path approximation. To this end all ladder diagrams with the "many-tower" exchange were summed up in the approximation mentioned. (auth)

19150 SOME TOPOLOGICAL PROPERTIES OF THE FEYNMAN GRAPHS. Kucheryavyi, V. I. (Inst. of Theoretical Physics, Moscow). Teor. Mat. Fiz.; 10: No. 2, 182-95(Feb 1972). (In Russian).

Some topological properties of the Feynman graphs are investigated on the basis of the already known conceptions and several new ones. These properties are represented in the form of relations connecting with each other the various matrices reflecting the topological structure of a graph. (auth)

19151 CURRENT FORMALISM IN THE NONRELATIVISTIC QUANTUM MECHANICS. Aref'eva, I. Ya. (Leningrad Mathematical Inst.). Teor. Mat. Fiz.; 10: No. 2, 223-37(Feb 1972). (In Russian).

The formalism of the nonrelativistic quantum mechanics in terms of the currents is considered. The functional representation of the current algebra is described, the current analog of the Araki theorem about the reconstruction of the Hamiltonian is obtained, and the perturbation theory in the current formalism for the scattering problem is constructed. (auth)

19152 SCATTERING PROBLEM FOR THE RADIAL SCHROEDINGER EQUATION WITH SLOWLY DECREASING POTENTIAL. Matveev, V. B.; Skriganov, M. M. (Leningrad State Univ.). Teor. Mat. Fiz.; 10: No. 2, 238-48(Feb 1972). (In Russian).

The scattering problem for the Schrödinger equation with slowly decreasing potential is considered. Stationary wave operators $W_\pm(H,H_0)$ are constructed and their completeness is proved. It is shown that the operators $W_\pm(H,H_0)$ can also be defined as the limits $W_\pm(H,H_0) = \lim_{t\to\pm\infty} \exp(itH)T_\pm \exp(-itH_0)$, $T_\pm$ being some operators, which do not depend on t, do not commute with H_0 and can be

constructed explicitly for the given potential q(x). The invariance principle for the wave operators $W_\pm$ is proved. (auth)

19153 DIAGONALIZATION OF THE SCHROEDINGER OPERATOR IN THE FOCK SPACE. Sigal, I. M. (Scientific Research Radiophysical Inst., Gorky, USSR). Teor. Mat. Fiz.; 10: No. 2, 249-58(Feb 1972). (In Russian).

The creation-annihilation operators of the bound complexes participating in the scattering process are constructed for a system of nonrelativistic quantum particles with pair interaction in the Fock space. These operators are the eigenfunctions of the operator H representing the operation of the commutation with the Hamiltonian $\hat{H}$ of the system. The operator $\hat{H}$ can be expressed as a quadratic form of these operators. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

Refer also to abstract 19183.

19154 THEORETICAL DECREASE OF SECOND-SOUND VELOCITY IN THE PRESENCE OF A MUTUAL FRICTION FORCE. Lhuillier, D.; Vidal, F.; Francois, M.; Le Ray, M. (Faculte des Sciences, Orsay, France). Phys. Lett.; 38A: No. 3, 161-3(31 Jan 1972).

New expressions for the mutual friction force and the entropy flux are derived thermodynamically. As a consequence, a first-order decrease of second sound velocity occurs in a supercritical flow as well as in rotation. This effect has been observed experimentally. (auth)

19155 ^{3}He CRYOSTAT PUMPING WITH ADSORPTION PUMP. Kovac, L.; Janos, S.; Greser, A. Cesk. Cas. Fys.; 22: No. 1, 20-1(1971). (In Czech).

A helium-3 cryostat with an adsorption pump for measurement of thermal and electrical conductivity in the range 0.4 to 4.2 K is described. (auth)

19156 HIGH FREQUENCY DEPOLARIZED LIGHT SCATTERING FROM LIQUID HELIUM I AND HELIUM GAS. Pike, E. R.; Vaughan, J. M. (Royal Radar Establishment, Great Malvern, Eng.). J. Phys., C (London); 4: No. 18, L362-6(31 Dec 1971).

A broad high-frequency depolarized peak was observed in the light scattered from liquid helium I at an energy of approximately twice the maximum of the dispersion curve. Spectra are shown and a number of possible explanations of the phenomenon are discussed. The corresponding spectrum for ^{4}He gas at 0.96 atm and 4.22°K was also observed and shows no structure. (auth)

19157 DENSITY DEPENDENCE OF THE HEAT CAPACITY ANOMALY IN LIQUID ^{4}He NEAR LAMBDA TRANSITION. McCoy, T.-H.; Graf, E. H. (State Univ. of New York, Stony Brook). Phys. Lett.; 38A: No. 4, 287-8(14 Feb 1972).

A series of precision measurements of the temperature variation of the constant-volume heat capacity C_V of liquid ^{4}He near the lambda transition is reported in samples covering the complete density range between the saturated vapor and freezing pressures. For He II, the C_V data have a temperature dependence close to logarithmic at all densities. For He I, C_V is close to logarithmic only at the lowest densities and obeys finite power laws at higher densities. (auth)

Superconductivity

Refer also to abstracts 18274, 18278, 18802, and 19607.

19158 (COO-1569-86) PAIR TUNNELING AS A PROBE OF ORDER PARAMETER FLUCTUATIONS IN SUPERCONDUCTORS: ZERO MAGNETIC FIELD EFFECTS. Anderson, J. T.; Carlson, R. V.; Goldman, A. M. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). [1970]. Contract AT(11-1)-1569. 37p. Dep. NTIS.

Thermal fluctuations of the order parameter in a superconductor above its transition temperature result in manifestations of the ordered state, which appears below the transition. In a Josephson junction consisting of two metals with different transition temperatures, there is associated with the incipient superconductivity an enhanced conductivity across the junction at temperatures between the transition temperatures of the two metals. The enhanced conductivity is observed as a current that flows in excess of the junction quasi-particle current. The excess current was investigated using $Sn/Sn_xO_y/Pb$ and $Al/Al_xO_y/Pb$ junctions masked to eliminate effects of graded film edges. Details of the variation of the excess current with voltage and temperature are in quantitative agreement with calculations in the $Al/Al_xO_y/Pb$ junctions. The excess current–voltage characteristic is a direct measure of the imaginary part of the generalized susceptibility above T_c. The pair relaxation frequency in aluminum based on the data is consistent with the theoretical value. (auth)

19159 (IPP-4/90) SUPERCONDUCTING DC POWER SOURCE. Kafka, W. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Sep 1971. 26p. (In German). Dep. NTIS (U. S. Sales Only).

A superconducting dc power source for superconducting coils is described, and its losses are compared with those of dc sources working at room temperature. It consists of a stationary superconducting winding and a rotating-field magnet. The commutator usually needed in dc machines is replaced by power cryotrons controlled by the rotating field. Commutation losses are largely avoided by, e.g., switch chokes. The device works at very low frequencies, so hard superconductors can be used. Economy of operation is governed by the losses occurring at low temperature. Losses due to hysteresis, self-field hysteresis, and eddy currents can be kept sufficiently low by using finely subdivided, interlaced filament conductors. It is then the cryotron losses that are crucial. They can only be reduced by means of longer cryotron conductors and appropriate superconductor material. Formulas for calculating the losses and the most important machine data are given. Calculations are made for a machine with 20 kA, 0.5 V, and 10 kW as example. (auth)

19160 (ITF-71-60-E) ON THE MODEL HAMILTONIAN OF THE THEORY OF SUPERCONDUCTIVITY. Petrina, D. Ya.; Yatsishin, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 35p. Dep. NTIS (U. S. Sales Only).

The model Hamiltonian of the theory of superconductivity is examined for infinite volume, and its spectrum is fully studied. A grand partition function is derived, a state function is found, and the phase transition from normal into a superconductive state is proved. It is also proved that, for $V = \infty$, a chain of the equations for the model Hamiltonian Green's functions has two solutions—the free Green function and the approximative Hamiltonian Green function. 33 references. (auth)

19161 (LBL-167) SUPERCONDUCTIVITY IN AMORPHOUS TRANSITION METALS. Collver, Michael Moore (California Univ., Berkeley. Lawrence Berkeley Lab.). Nov 1971. Contract W-7405-eng-48. 134p. Dep. NTIS.

Thesis.

Superconducting transition temperatures of vapor-quenched 4d and 5d transition elements and alloys were measured. Most of the T_c structure associated with crystalline solid solution alloys (Matthias-type curve) is absent in the disordered or amorphous state. T_c was found to be a simple function of the number of electrons per atom, rising to a single maximum near the middle of the d-series at $e/a \simeq 6.4$ and 6.8 to 7 for the 4d and 5d alloys, respectively. A strong correlation between T_c and the number of unpaired d-electrons in the atom exists. The data are analyzed in terms of existing equations for the transition temperature, where extensive use is made of a model relating the electron–phonon coupling parameter to the cohesive energy. Annealing studies of the films were also made and included: monitoring of specimen resistance to 350°K, remeasurement of T_c after heating, high-temperature annealing (500 to 1100°K), and electron microscopy. Alloy films exhibiting a sharp decrease in resistance within a narrow temperature range during heating had T_c's (after annealing) that approached or equaled those of corresponding bulk crystalline materials. Electron diffraction and microscopy of the untransformed films demonstrated the absence of grains down to 10 to 15 Å in diameter. A discussion of the stability of the amorphous structure is given, and an irreversible phase diagram is presented. (auth)

19162 (NYO-2391-114) HOLSTEIN PROCESS IN SUPERCONDUCTORS: A NEW SUM RULE. Braendli, G. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Oct 1971. 11p. Dep. NTIS.

Absolute measurements in the far-infrared on superconducting Pb and Pb–In alloys show an enhanced surface resistance at the phonon frequencies, which is due to the Holstein process. These results fit a new sum rule for the surface resistance, and reveal an inherent relation between the Holstein process and superconductivity. (auth)

19163 (SLAC-Trans-139) INFLUENCE OF EXTENDED DEFECTS ON THE SUPERCONDUCTIVE PROPERTIES OF NIOBIUM. Goodman, B. B.; Kuhn, G. Translated by A. Roder for Stanford Linear Accelerator Center, Calif., from J. Phys. (Paris); 29: 240-52(Feb-Mar 1968). 36p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 26327.

19164 ION MOBILITIES IN ^{4}He NEAR THE SUPERFLUID TRANSITION AND THE MELTING LINE. Ahlers, G.; Gamota, G. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Lett.; 38A: No. 2, 65-6(17 Jan 1972).

Ion mobility measurements in ^{4}He are reported that indicate singular Stokes radii for negative and positive ions at T_λ and

($T_\lambda - 0.04K$) respectively. No anomaly in the mobility for either species was detected near melting. (auth)

19165 STABILITY OF TRIANGULAR AND SQUARE FLUX-LINE LATTICES IN TYPE-II SUPERCONDUCTORS. Brandt, E. H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Lett.; 38A: No. 2, 71-2(17 Jan 1972).

The free energy of the vortex lattice is calculated by varying the Ginzburg–Landau functional with respect to two-dimensional test functions. The triangular lattice is shown to be stable in the whole field region. (auth)

19166 ANISOTROPIC LENGTH CHANGES AT THE SUPERCONDUCTING TRANSITION OF ZINC. Ott, H. R. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 38A: No. 2, 83-4(17 Jan 1972).

The length changes of zinc single crystals were measured at the field-induced transition from the superconducting to the normal state between 0.3 and 0.8°K. A strong anisotropy in the deformations parallel and perpendicular to the hexagonal axis was observed. At T = 0°K the relative length changes are $(l_s - l_n)/l_s = 1.4 \times 10^{-5}$ parallel and $(l_s - l_n)/l_s = -0.4 \times 10^{-5}$ perpendicular to the hexagonal axis. The pressure dependences of the critical field H_c and the critical temperature T_c were calculated from the experimental data. (auth)

19167 SUPERCONDUCTIVITY OF BISMUTH TELLURIDE. Il'ina, M. A.; Itskevich, E. S. (Inst. of High-Pressure Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 2098-2100(Feb 1972).

Translated from Fiz. Tverd. Tela; 13: No. 8, 2496-9(Aug 1971).

A p-type sample of Bi_2Te_3 with a hole density of 1.5×10^{18} cm^{-3} was investigated in the pressure range 60 to 100 kbars. Resistance discontinuities corresponding to transitions to the superconducting state were observed at pressures between 65 and 100 kbars. Two such discontinuities were observed at P > 71 kbars but the high-temperature discontinuity at P > 90 kbars was slight. The value of the transition temperature T_c was assumed to correspond to the midpoint of the discontinuity. (M.H.R.)

19168 INVESTIGATION OF SUPERCONDUCTIVITY IN SEMICONDUCTORS. Golub, A. A.; Kon, L. Z. (Inst. of Applied Physics, Kishinev, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 2054-6(Feb 1972).

Translated from Fiz. Tverd. Tela; 13: No. 8, 2455-8(Aug 1971).

An equation is obtained for the energy gap at zero temperature from the steady-state condition of the thermodynamic potential. The interaction, which leads to superconductivity, is expressed in terms of the dielectric constant of the crystal and contains nonresonant denominators. The region of small momentum transfer is investigated in detail. The case when the frequency of optical phonons is of the order of the plasma frequency is considered. (auth)

19169 ORDER OF ITINERANT ANTIFERROMAGNETIC PHASE TRANSITIONS AND SUPERCONDUCING PHASE TRANSITIONS IN AN EXCHANGE FIELD. Malaspinas, Andreas (Eidgenoessische Technische Hochschule, Zurich); Rice, T. M. Phys. Kondens. Mater.; 13: No. 3, 193-202(1971).

The coefficients of the second- and fourth-order terms in a Landau expansion of the free energy are evaluated for an itinerant antiferromagnetic transition. The choice of spatial dependence is found to play an important role. A first-order transition is obtained for a range of values of the band-structure parameters. However, if values appropriate to Cr are used, it is found that the contribution from the shift in the Fermi level is sufficiently large to give second-order transitions even when magnetostrictive effects are included. In the mathematically similar problem of a superconductor in an exchange field it is found that the transition from normal to superconducting states is first order near the triple point, with an upper and possibly a lower critical point where the transition changes to second order. (auth)

19170 IMPROVEMENTS IN AND RELATING TO SUPERCONDUCTORS. Burgess, John Ronald; Major, Rodney Victor; Everett, George William (to Telcon Metals, Ltd.). British Patent 1,260,673. 19 Jan 1972. Filed 23 Apr 1968.

An object of the process described is the production of clad superconducting wires, in single core and multiple core forms, to meet the requirements that the coatings have good electrical and mechanical contact with the core over the entire length. The process comprises the following steps: inserting a superconducting rod or wire into a Cu or Al tube; cold drawing the composite clad superconductor to impart a cross-sectional configuration allowing plane contact with adjacent strands when arranged in a core; threading such a core into a close-fitting outer tube of high conductivity metal, linear contact being maintained between adjacent strands over substantially their entire perimeter; finally subjecting the assembly to cold working by drawing and/or rolling, to produce a coherent whole. The thickness of the cladding material is determined by the application for which the wire is required. Provision is made for mechanical and/or chemical cleaning the rod or wire and the bore of the Cu or Al tube to produce a bright finish, free from surface contamination and defects. Examples are given for Nb/Ti in Cu. (UK)

19171 RELAXATION OSCILLATOR MODEL FOR SUPERCONDUCTING BRIDGES. Deaver, B. S. Jr.; Pierce, J. M. (Univ. of Virginia, Charlottesville). Phys. Lett.; 38A: No. 2, 81-2(17 Jan 1972).

Using an equivalent circuit including an intrinsic inductance, measurements reported for thin film bridges are interpreted in terms of a relaxation oscillation at the Josephson frequency. (auth)

19172 OSCILLATORY FLUX LINE PROFILES NEAR T = T_c. Jacobs, A. E. (Univ. of Toronto). Phys. Lett.; 38A: No. 3, 153-4(31 Jan 1972).

It is shown, using the theory of Eilenberger and Büttner, that the deviation of the order parameter from the BCS value far from the axis of an isolated vortex is an exponentially damped function, not a weakly damped oscillatory function. (auth)

19173 FREQUENCY DEPENDENCE OF THE JOSEPHSON CURRENT. Hamilton, C. A. (Univ. of Rochester, N. Y.). Phys. Rev., B; 5: No. 3, 912-23(1 Feb 1972).

Careful measurements were made of the power and frequency dependence of the ac Josephson steps in a superconducting tunnel junction exposed to 20- to 26-GHz microwave radiation. At values of $2\alpha = 2eV_{rf}/hf > 25$, significant deviations from Bessel-function behavior $[J_N(2\alpha)]$ begin to occur. These deviations are caused by a sharp peak in the Josephson current at a frequency $f_J = 4\Delta/h$, i.e., the Riedel peak. The experimental data are used to measure the shape of this peak. Simultaneous measurements of the Josephson and quasi-particle effects are also presented. These results demonstrate that the two effects have the theoretically predicted correlation. The experiments as a whole demonstrate the theory of superconducting tunnel junctions to be on very firm experimental ground. (auth)

19174 PEAK IN THE CURVES OF CRITICAL CURRENT OF SUPERCONDUCTING V_3Si. Pulver, M. (Univ., Giessen, Ger.). Phys. Status Solidi (b); 49: No. 1, K95-8(1 Jan 1972).

The peak effect (maximum in critical current at higher magnetic fields) was studied in transverse fields up to 37 kOe in V_3Si single crystals. The peak effect does occur in a perfect single crystal, and annealing at 1200°C does not remove the peak. However, for an imperfect single crystal, annealing does result in the disappearance of the peak. It is concluded that the peak effect occurs only in materials with large regions of the same crystal orientation and weak pinning. (D.L.C.)

19175 NOTE ON THE CURRENT-CARRYING SUPERCONDUCTING CYLINDER. Samuelsen, M. R. (Tech. Univ. of Denmark, Lyngby). Phys. Status Solidi (b); 49: No. 1, K53-6 (1 Jan 1972).

When the current I through a long superconducting cylinder with radius a reaches the critical value $I_c = 2\pi aH_c$, the cylinder goes into the intermediate state with a resistance R. For currents larger than I_c, the cylinder may be viewed as a cylindrical core of radius r_0 in the intermediate state, surrounded by a shell in the normal state (R_N). The magnetic field at the interface is the critical field H_c. It is shown that R/R_N, r_0/a, and the distribution of the magnetic induction in the normal shell as functions of I/I_c are determined by x, the jump in R/R_N when I reaches I_c. Equations are derived, and plots of r_0/a and R/R_N vs I/I_c are given for x = 1.0 to 0.5. (D.L.C.)

19176 INFLUENCE OF MATERIAL PROPERTIES ON THIRD HARMONIC GENERATION IN THIN SUPERCONDUCTING FILMS. Bomer, R. P.; Beck, A. H. (Cambridge Univ., Eng.). pp 4.1-6 of MOGA 70. Deventer, Netherlands; N.V. Uitgeversmaatschappij Kluwer (1970).

From eighth international conference on microwave and optical generation and amplification; Amsterdam, Netherlands (7 Sep 1970). See CONF-700914.

The third harmonic generation from "inductive posts" of superconducting tin and tantalum films in TE_{01n} cavities was investigated. It was hoped to investigate the effects of a dc bias and a bias magnetic field, as well as film thickness, temperature, and incident power. Results were incomplete, but some interesting points observed are discussed. (M.H.R.)

19177 BAROMETRIC FORMULA IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Ciubotariu, C. D. (Polytechnic Inst., Iasi). J. Phys., A (London); 5: No. 1, L1-3(Jan 1972).

It is shown that if the space–time of a system composed of a perfect fluid coupled to a frozen-in magnetic field has two Killing vector fields, one of them collinear to four-velocity and the other proportional to the magnetic field, a barometric formula is obtained from which the influence of the magnetic field on the pressure distribution is found. (auth)

19178 INTRODUCTION TO THE JOSEPHSON EFFECTS. Petley, B. W. M and B Technical Library TL/EE/2. London; Mills and Boon (1971). 88p. £2.50.

The subject is dealt with under the headings: the basic equations describing the Josephson effects (the Josephson equations, the general barrier phase equation), the cutoff frequency and the time rate of change of phase, Josephson effects without a voltage across the barrier (the effect of a magnetic field, the plasma resonance), effects with a direct voltage across the barrier (no applied alternating voltage across the barrier, detection of the ac Josephson supercurrent, radiation incident on the barrier), other configurations exhibiting Josephson effects (single junctions, multiple junctions including double junctions methods of constructing Josephson junctions), the Josephson effects in liquid helium II, further applications of the Josephson effects. (UK)

19179 LOCAL MODEL OF NONIDEAL TYPE-II SUPERCONDUCTORS. I. CRITICAL CURRENT DENSITY. Matsunaga, Sakuro (Japan Atomic Energy Research Inst., Tokai). Jap. J. Appl. Phys.; 11: No. 2, 255-62(Feb 1972).

The local model of nonideal Type-II superconductors with pinning force is presented by modifying a general solution of the London equation. The local field around the core is deformed by the transport current. This deformation satisfies the London equation and is represented in a form so that the nature of the pinning force is included. The critical current density J_c is given by polynomial $J_c = \Sigma_{m=1} A_{2m-1} J_{t(2m-1)}$, and the first term J_{t1} agrees with that in the Coffey's model (Phys. Rev., 166:447(1968)), which explains the experimental results on Nb_3Sn and heat-treated Nb–22 at. % Ti. Inclusion of terms with m > 1 can explain a variety of Jc–H plateau curves, peak effect, etc. The amplitude A_{2m-1} and mode m of the deformation vary with the kinds of lattice defects to pin fluxoids, and these are required to be independent of an applied magnetic field but dependent on the temperature. (auth)

19180 AC SUPERCONDUCTING ARTICLES AND A METHOD FOR THEIR MANUFACTURE. (to Union Carbide Corp.). British Patent 1,261,543. 26 Jan 1972. Priority date 30 Jan 1968, United States.

A superconducting device for continuously propagating or sustaining a high-energy-density alternating electromagnetic field is described. This device consists wholly, or in part, of an electrolytically deposited layer of niobium, having no more than the following impurities in parts per million: C < 1, O_2 < 50, H_2 < 1, N_2 < 1, Fe < 18, Ni < 20, Cr < 20, Ta < 10, and W < 2. This device is adapted to be maintained in contact with a cryogenic fluid at a temperature below the transition temperature of niobium. A method for fabricating the device is described. (M.H.R.)

19181 NEW MODEL FOR CRITICAL STATE OF TYPE-II SUPERCONDUCTORS. Kirschner, I.; Martinas, K. (Lorand Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 3, 331-5(1971).

According to the principle of the proposed model, the different critical currents (as found in experiments) can be explained by supposing that one part of the vortices is unbound, while their other part is bound. (L.M.T.)

19182 DISLOCATION MOTION IN THE NORMAL AND THE SUPERCONDUCTING STATES. Suenaga, M.; Galligan, J. M. (Brookhaven National Lab., Upton, N. Y.). Scr. Met.; 5: No. 10, 829-36(Oct 1971).

A theory based on a vibrating-string model of dislocation developed previously is outlined, and some of its predictions are compared with experimental results. It is concluded that the present model is in good qualitative agreement with experimental results related to the influence of specific impurities, as well as concentration. However, the predicted temperature dependence of $\Delta\sigma_{N-S}$ is not entirely satisfactory. Additional improvements are needed, especially in understanding the nature of the viscosity involved in dislocations moving through the electrons. (M.H.R.)

19183 PHONON INTERFERENCE IN THIN HELIUM FILMS USING SUPERCONDUCTING TUNNEL JUNCTIONS. Blackford, B. L. (Royal Society Mond Lab., Cambridge, Eng.). Phys. Rev. Lett.; 28: No. 7, 414-17(14 Feb 1972).

Phonon interference was observed in adsorbed helium films at frequencies above 100 GHz. Superconducting tunnel junctions were used as generators and detectors of the monochromatic phonons. (auth)

19184 EXPLANATION OF THE LOW-TEMPERATURE, HIGH-FREQUENCY RESIDUAL SURFACE RESISTANCE OF SUPERCONDUCTORS. Passow, C. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 28: No. 7, 427-31(14 Feb 1972).

It is shown that the residual high-frequency surface resistance found in the purest currently prepared superconductors can be explained in terms of the generation of sound waves by the incident electromagnetic radiation. This effect is negligible in normal metals, but is shown here to account quantitatively for the measured temperature and frequency dependence of the residual radio-frequency losses of superconductors. (auth)

19185 DEGRADATION AND REENHANCEMENT OF THE PEAK CRITICAL CURRENT IN SUPERCONDUCTING LEAD. Winter, J. J.; Leupold, H. A.; Breslin, J. T. (Army Electronics Command, Fort Monmouth, N. J.). J. Appl. Phys.; 43: No. 2, 631-6(Feb 1972).

Certain samples of the type discussed in a previous article were shown to exhibit greatly broadened I–R transitions. Although the axial asymmetry of the sample appears to induce the broadening, the transition can be made to approach that of a right circular cylinder of lead by certain surface treatments or by flux trapping. A simple qualitative model is outlined to correlate these phenomena. (auth)

19186 JOSEPHSON JUNCTION AS A FREQUENCY ANALYSER AND MIXER OF SUBMILLIMETRE RADIATION SOURCES. Blaney, T. G.; Bradley, C. C. (National Physical Lab., Teddington, Eng.). J. Phys., D (London); 5: No. 1, 180-4(Jan 1972).

In an extension of earlier work, the response of niobium–niobium point-contact Josephson junctions to radiation from hydrogen cyanide and deuterium cyanide lasers was studied. Constant voltage steps corresponding to the 805, 891 and 964 GHz lines from a HCN laser were observed as well as steps corresponding to the frequency mixtures of all these lines. In addition, subharmonic and harmonics of "mixed-frequency" steps were also observed. The first observation of Josephson step structure corresponding to the 1540 and 1578 GHz emissions of a DCN laser is reported. (auth)

19187 FIELD GRADIENT INDUCED BY ORGANIC INTERCALATION OF SUPERCONDUCTING LAYERED DICHALCOGENIDES. Ehrenfreund, E. (Bell Telphone Labs., Murray Hill, N. J.); Gossard, A. C.; Gamble, F. R. Phys. Rev., B; 5: No. 5, 1708-11(1 Mar 1972).

Magnetic-resonance observations of niobium nuclei in both the layered dichalcogenide NbS_2 and the associated intercalation complex NbS_2 (pyridine)$_{\frac{1}{4}}$ yield different electric field gradients in the two compounds. At 4.2°K, e^2qQ/h = 60 MHz in NbS_2 and 46 MHz in $NbS_2(Py)_{\frac{1}{4}}$. The difference is shown to arise from the conduction-electron term. It may result from charge transfer between the organic molecules and the conduction band of the layered dichalcogenide, or from redistribution of electrons between two overlapping conduction bands. The lattice sum for the field gradient is shown to be derived almost entirely from intralayer charges. (auth)

19188 EFFECT OF LATTICE INSTABILITIES ON SUPERCONDUCTING AND OTHER PROPERTIES IN TaC/sub x/. Zeller, H. R. (Brown Boveri Research Center, Baden, Switzerland). Phys. Rev., B; 5: No. 5, 1813-17(1 Mar 1972).

Tunneling measurements performed on TaC_x single crystals and recently published neutron-scattering data show that stoichiometric TaC is in the vicinity of a lattice instability. This leads to a strong dependence of many physical properties on carbon content. It is shown that TaC_x can be well described by a very simple model in which the band structure is considered composition independent while the vibrational spectrum strongly depends on carbon content. In particular, the effect of the anomalous phonon spectrum on superconductivity is discussed. Phillips's ideas about the relation between the instability and superconductivity are supported. The lattice instability is discussed in terms of a hard-sphere model. A consistent picture relating the unusual superconducting, electrical, and mechanical properties in TaC is found. (auth)

19189 CALCULATION AND MEASUREMENT OF THE ELECTRONIC PART OF THE THERMAL CONDUCTIVITY OF A STRONG-COUPLING SUPERCONDUCTOR IN WHICH ELASTIC SCATTERING OF THE ELECTRONS DOMINATES. Mrstik, B. J.; Ginsberg, D. M. (Univ. of Illinois, Urbana). Phys. Rev., B; 5: No. 5, 1817-23(1 Mar 1972).

The theoretical expression for the electronic contribution K_{es} to the thermal conductivity in strong-coupling superconductors was generalized to include elastic scattering of the electrons. In the limit where the elastic scattering dominates, the resulting

expression for K_{es} is equivalent to that of Bardeen, Rickayzen, and Tewordt except for a charge in the energy-gap width; the renormalization function Z_s does not explicitly appear. Measurements of the thermal conductivity of quench-condensed lead films were made, which are in very good agreement with the theory, with no adjustable parameters. (auth)

19190 SUPERCONDUCTING PAIR STATES FOR TRANSITION METALS IN THE ATOMIC REPRESENTATION. Appel, J. (Gulf General Atomic Co., San Diego, Calif.); Kohn, W. Phys. Rev., B; 5: No. 5, 1823-30(1 Mar 1972).

This paper is a sequel to one by the authors (Phys. Rev., B4: 2162(1971)) in which the theory of superconductivity was cast into the Wannier (or atomic) representation. This representation should be especially useful for narrow-band superconductors. In the present paper, group theoretical methods are used to show how to construct appropriately symmetrized pair states in this atomic representation. Specific applications to s and d bands in bcc and fcc lattices, and to d bands in β-tungsten structures are worked out. (auth)

19191 EFFECT OF NONMAGNETIC LOCALIZED STATES IN Al FILMS WITH ENHANCED T/sub c/. Hauser, J. J. (Bell Labs., Murray Hill, N. J.). Phys. Rev., B; 5: No. 5, 1830-3 (1 Mar 1972).

Mixtures of Al with 10 wt % Al_2O_3 and various concentrations of transition-metal elements (Cr, Mn, Fe) were sputtered at 77°K and their transition temperature (T_c) was measured without warming above 77°K. The transition temperature (T_{co}) of the reference Al–10-wt %-Al_2O_3 mixture is approximately 3°K. In agreement with Kaiser's theory, T_c depends exponentially on the transition-metal concentration. The excellent agreement between film data and bulk data provides further proof that many electronic properties, in particular the density of states, of the aluminum with enhanced T_c are very close to bulk values. (auth)

19192 MAGNETIC TRANSITIONS OF SUPERCONDUCTING THIN FILMS AND FOILS. III. Pb, Sn, AND In. Cody, G. D.; Miller, R. E. (RCA Labs., Princeton, N. J.). Phys. Rev., B; 5: No. 5, 1834-43(1 Mar 1972).

New measurements are reported for the superconducting-to-normal transition of Pb films to reduced temperatures (T/T_c) as high as 0.995. A comparison is made of the Ginzburg–Landau parameter, κ, for Pb, Sn, and In, derived from thin-film measurements (κ_F) and values of κ derived from supercooling and superheating studies (κ_{sc}) by Smith, Baratoff, and Cardona. The comparison reveals large discrepancies between κ_F and κ_{sc}, which is supported by similar measurements on Al by Maloney and de la Cruz. The discrepancy can be associated with a unique sensitivity of the thin-film transitions to nonlocality, but there is at present no rigorous theory. (auth)

19193 THERMODYNAMICS OF THE DOMAIN STRUCTURE AND DETERMINATION OF THE TRANSITION FIELDS IN TYPE-1 SUPERCONDUCTORS. Fortini, Andre; Paumier, Eric (Univ., Caen, France). Phys. Rev., B; 5: No. 5, 1850-8(1 Mar 1972).

A detailed electromagnetic and thermodynamical theory of the intermediate state in Type-1 superconductors is worked out in the Landau laminar geometry. It is shown that the Landau s domain bounded by a convex well where the magnetic field very nearly approaches the critical value is likely to be near the most stable configuration. The analysis of the field distribution in the n laminas provides a qualitative explanation of the experimentally observed small importance of the branching that Landau first suggested. Explicit analytical expressions of the various contributions to the free energy are derived as functions of the applied magnetic field and of the superconductive fraction. This allows the exact formulation of the equations yielding the transition fields at the ends of the intermediate range. At the lowest order, the departure of the field from the ideal value varies predominantly as $(\Delta/l)^{\frac{1}{3}}$ at the diamagnetic intermediate-phase transition and as $(\Delta/l)^{\frac{1}{4}}$ at the intermediate normal-phase transition, Δ being the surface energy and l the thickness of the sample. (auth)

19194 THERMAL CONDUCTIVITY OF STRONG-COUPLING SUPERCONDUCTORS. Vashishta, P. (Argonne National Lab., Ill.); Carbotte, J. P. Phys. Rev., B; 5: No. 5, 1859-61(1 Mar 1972).

The electronic thermal conductivity of Pb was calculated using realistic (derived from tunneling) kernels in the Eliashberg-gap equations, which were solved for several temperatures below and near T_C. The computations are based on the theory of Ambegaokar and Tewordt. Complete results are also obtained for the case of Hg. A rough evaluation of thermal conductivity for In and Tl is also included. (auth)

19195 STRUCTURE AND STABILITY OF SUPERCONDUCTING MAGNETS. Koyama, Ken-ichi. Denki Shikensho Iho; 35: No. 8, 716-26(1971). (In Japanese).

Several superconducting magnets were tested to clarify relations between their stability and their structures, and further to develop stable superconducting magnets for laboratory experiments. An electrical circuit feeding the current to the magnet is also developed to rationalize the experiments. It is found that superconducting magnets with low-copper-ratio wire show instability explainable by the ordinary magnetization instability theory, but that the characteristics of magnets with high-copper-ratio wire are so stable that they cannot be explained by the theory. A flux-frozen model that makes it possible to understand them is proposed. Lastly, it is shown that a superconducting magnet of the above-mentioned structure comes to be in danger of being burned if its magnetic stored energy becomes larger than about 100 kJ. (auth)

19196 MAGNETIC RELAXATION AND EDDY CURRENT DAMPING IN THIN FILM SUPERCONDUCTORS. Huebener, R. P.; Aspen, F. E. (Argonne National Lab., Ill.). Solid State Commun.; 10: No. 1, 29-32(1 Jan 1972).

The magnetic relaxation in superconducting lead films was studied using the resistive-voltage enhancement, and measurements were made with pickup coils in an oscillatory magnetic field component. At approximately the same frequency, a relaxation peak was observed in both the resistive and the pickup voltage. A simplified treatment of the relaxation time τ for magnetic flux penetration is given for the case of a demagnetizing factor close to 1.0, using an energy-balance argument due to Faber (Proc. Roy. Soc. (London), A223: 174(1954)). Very reasonable agreement is obtained between the experimental and the calculated values of τ. (auth)

19197 THERMAL CONDUCTIVITY OF SUPERCONDUCTING LEAD–INDIUM ALLOYS NEAR THE UPPER CRITICAL FIELD. Gupta, A. K.; Wolf, S.; Chandrasekhar, B. S. (Case Western Reserve Univ., Cleveland). Solid State Commun.; 10: No. 1, 57-60(1 Jan 1972).

The thermal conductivity of a series of lead–indium alloys was measured in the normal, superconducting, and mixed states at 1.25 to 7.5°K. The electronic part of the thermal conductivity near the upper critical field was compared with the theory of Caroli and Cyrot (Phys. Kondens, Mater., 4: 285(1965)). There is good agreement in the dirty limit, but large deviations are observed as the indium concentration is reduced. (auth)

19198 TEMPERATURE DEPENDENCE OF THE CRITICAL MAGNETIC FIELD OF SUPERCONDUCTORS. Nowotny, H.; Hittmair, O. (Technische Hochschule, Vienna). Acta Phys. Austr.; 32: No. 3-4, 303-16(Mar 1970). (In German).

It was found that the deviation of the temperature dependence of the critical magnetic field of various superconductors from the law of the corresponding states can be obtained essentially by a simple frequency pattern of the energy vacancy function. The individual superconductor is characterized by a parameter given by the ratio of the gap temperature to a mean phonon energy. (tr-auth)

19199 SUPERCONDUCTIVITY OF DOUBLE CHALCOGENIDES: $Li_xTi_{1+}S_2$. Barz, H. E.; Cooper, A. S.; Corenzwit, E.; (and others) (Bell Telephone Labs., Inc., Murray Hill, N. J.). Science; 175: No. 4024, 884-5(25 Feb 1972).

Lithium titanium sulfides, $Li_xTi_{1+}S_2$ ($0.1 < x \leq 0.3$), become superconducting over the temperature range from 10 to 13°K. They have the hexagonal Ti_3S_4 structure and should not be considered intercalation compounds. This is the first class of noncubic compounds with high transition temperatures. (auth)

Equipment and Devices

Refer also to abstracts 17800, 18471, and 19176.

19200 JOSEPHSON-JUNCTION AMPLIFIER. Clarke, John; Paterson, James L. (Univ. of California, Berkeley). Appl. Phys. Lett.; 19: No. 11, 469-71(1 Dec 1971).

Positive feedback is used within a double-Josephson-junction quantum interferometer to achieve a current amplification that can be adjusted from outside the cryostat over the range 1 to 100. The interferometer may be regarded as a three-terminal amplifying device. (auth)

PHYSICS (NUCLEAR)

19201 (CONF-701219-(Vol.1)) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, MADURAI, DECEMBER 27–30, 1970. VOLUME I. INVITED TALKS. (Department of Atomic Energy, Bombay (India). Physics Committee). 1970. 160p.

Separate abstracts were prepared for three of the nine papers included. The remaining six papers are outside the scope of NSA. (J.W.R.)

For abstracts of individual papers see: 19334, 19335, and 19447.

19202 (EUR-4734) ANNUAL PROGRESS REPORT, 1970. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). 8 Aug 1971. 66p. Dep. NTIS (U. S. Sales Only). EUR F.Fr. 9.45.

The report summarizes the measurement results and the technical development in 1970 of the Central Bureau for Nuclear Measurements (Euratom, Geel). The report is subdivided into three headings: Neutron measurements—cross section determinations are described, and details are given for data handling and for the operation of a linear accelerator and a Van-de-Graaff; Nuclear technology and physics—activities in the fields mass spectrometry, radioprotection, dosimetry, electronics and measurements on radionuclides are summarized; Sample preparation—production and assaying techniques used in chemistry, metallurgy, classical metrology and vacuum evaporation are indicated. A series of tables summarizes information on delivered samples. A list of 43 reports and published papers is given. (auth)

Neutron Interactions with Matter

Refer also to abstracts 18473–18475, 18482, 19878, and 19880.

19203 METHOD FOR EXCLUDING THE FLIGHT LENGTH EFFECT IN EXPERIMENTS ON THE NONSTATIONARY DIFFUSION OF NEUTRONS. Antonov, A. A.; Vo Dac Bang; Isakov, A. I.; Merkul'ev, Yu. A. Kratk. Soobshch. Fiz.; No. 1, 58–65 (1971). (In Russian).

A method was developed for determining the effect of flight length in measurements of exponential damping of the thermal neutron distribution with time. The method was used in experiments on Zr hydride and H_2O moderators. (J.W.R.)

19204 SECOND ITERATED APPROXIMATION OF THE SYNTHETIC THERMALIZATION MODEL. Pomponiu, C.; Protopopescu, V.; Corciovei, A. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 6, 595-605(1971).

The generalized Cadilhac thermalization model is applied in the case n = 2 for the numerical computation of the functions $k_2(y)$ and $j_2(y)$ for the chosen model, in the thermal region. For the moderator the authors use a model similar to the Egelstaff's one and for the calculation of the moments a method pointed out by Soule which consists in transforming integrals such that they become more rapidly convergent. (auth)

19205 MAGNETIC SCATTERING OF NEUTRONS BY SEVERAL UNFILLED SHELLS CONFIGURATIONS. Mahendra, A.; Khan, D. C. (Indian Inst. of Tech., Kanpur). J. Phys., C (London); 4: No. 18, 3307-21(31 Dec 1971).

The tensor formalism developed by Johnston for the elastic scattering of neutrons by magnetic salts is extended to several-unfilled-shells configurations. The case of two shells is investigated completely. Some examples of the crystals having this configuration are presented and a simple example of the U^{4+} ion is worked out. The method for the generalization of the theory to a configuration of N shells is given. (auth)

19206 NEUTRON SCATTERING FROM A FINITE LINEAR CHAIN. Sobhana, S.; Ghatak, A. K. (Indian Inst. of Tech., New Delhi). Phys. Status Solidi (b); 49: No. 1, K75-7(1 Jan 1972).

For a one-dimensional monatomic lattice, equations are derived for the coordinates, normal mode frequencies, phonon expansion, and the matrix element M of transition for a zero-phonon process. Since the differential elastic scattering cross section is proportional to $|M|^2$, $|M|^2$ is plotted vs k_a, the neutron wave vector length, for a 5-atom and 10-atom lattice. (D.L.C.)

19207 NEUTRON FLUX PERTURBATIONS DUE TO ABSORBING FOILS. Morsy, S.; Williams, M. M. R. (Queen Mary Coll., London). J. Phys., D (London); 5: No. 1, 6-11(Jan 1972).

An assessment is made of the accuracy of the variational method for calculating neutron reaction rates in plane foils in problems involving velocity-dependent cross sections. This is achieved by using a separable scattering kernel and cross sections which are inversely proportional to velocity, thereby allowing the problem to be solved by analytic methods. It is found that the error in the reaction rate, as calculated by the variational method, is at most 7%. This error is an order of magnitude larger than that incurred in one-speed calculations. (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 19002, 19413, and 19449.

19208 $\alpha\alpha$ SCATTERING AT LOW ENERGIES IN THE METHOD OF COMPLEX ANGULAR MOMENTA. Grushin, V. V.; Nikitin, Yu. P. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 14: No. 3, 596-9(Sep 1971). (In Russian).

Application of the complex-angular-momentum method to the description of elastic $\alpha-\alpha$ scattering at α-particle energies up to 12 MeV is shown. Coulomb interaction and identity of the α particles are taken into account. The one-pole formula describes the $\alpha-\alpha$ scattering satisfactorily in the region of three low-lying excited states of the ^{8}Be nucleus. (2 figures) (auth)

19209 FOUR-NUCLEON SYSTEM. NEUTRON–TRITIUM SCATTERING. Permyakov, V. P.; Pustovalov, V. V.; Fenin, Yu. I.; Efros, V. D. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 3, 567-76(Sep 1971). (In Russian).

The problem of neutron–tritium scattering is considered. An essential feature of the method used is the decomposition of the Ψ function over the multidimensional angular harmonics in the region where all the nucleons interact. The corresponding equations are obtained and solved. The results obtained enable one to conclude that the first approximation of the method in the four-nucleon scattering problem has sufficient accuracy and that central pair local potentials without repulsion at small distances are not sufficient to describe experimental data on the scattering cross section. (1 figure, 1 table) (auth)

19210 TRITON CALCULATIONS WITH PHASE-EQUIVALENT NUCLEON–NUCLEON INTERACTIONS. Hadjimichael, E. (State Univ. of New York, Stony Brook. Fairfield Univ., Conn.); Jackson, A. D. Nucl. Phys.; A180: No. 1, 217-24(1972).

Haftel and Tabakin have recently generated a series of potentials by applying a unitary transformation to the Reid potential. The new potentials have a short-range non-locality but reproduce exactly the two-body observables calculated with the Reid potential. Several of these potentials were used to calculate the triton binding energy, rms radius, S-, D- and S'-state admixture probability and charge form factor. It was found that these triton observables are sensitive to the short-range part of the nucleon–nucleon interaction, and it is concluded that the triton can be used confidently to test phenomenological and field-theoretically derived models of the short range portion of the nucleon–nucleon interaction. (auth)

19211 E2 TRANSITION IN THE PHOTODISINTEGRATION OF ^{3}He. Barbour, I. M. (Univ. of Glasgow); Hendry, J. E. Phys. Lett.; 38B: No. 3, 151-4(7 Feb 1972).

The E2 transition amplitude in the photodisintegration of ^{3}He is calculated in a three-body formalism and compared with the existing experimental data. (auth)

19212 NEUTRON POLARIZATION FROM THE D(d,n)^{3}He REACTION AT 10.8 MeV INCIDENT DEUTERON ENERGY. Dunscombe, P. B.; Blyth, C. O.; McKee, J. S. C.; Pope, C. (Univ. of Birmingham, Eng.). J. Phys., A (London); 5: No. 1, L13-14(Jan 1972).

The polarization of neutrons from the D(d,n)^{3}He reaction at 10.8 MeV incident energy was measured at six angles between 35 and 60°_{lab}. The results of the experiments are in agreement with recent unpublished work. (auth)

19213 EFFECT OF ATOMIC EXCITATION ON THE SHAPE OF THE ^{3}H BETA SPECTRUM NEAR THE END POINT. Scott, R. D. (Scottish Research Reactor Centre, Glasgow). J. Phys., A (London); 4: No. 6, L105-9(Nov 1971).

The effect of atomic excitation on the shape of the ^{3}H beta spectrum near the end point is calculated and found to be small.

However, depending on the type of spectrometer and the method of analysis of data, the effect could lead to a systematic error which is not negligible compared with the accuracies quoted in some recent determinations of the end point. (auth)

19214 TOTAL NEGATIVE MUON-CAPTURE RATE IN THE α-PARTICLE. Srivastava, B. K.; Mahanti, D.; Yadav, H. L. (Indian Inst. of Tech., Kharagpur). Nucl. Phys.; A181: No. 1, 217-24(1972).

The total capture rate of negative muons in the α-particle (^{4}He) is calculated in the closure approximation by applying Primakoff's theory as modified by Goulard et al. to include relativistic corrections. The ground state of the α-particle is assumed to contain a mixture of the $^1S_0$ state and the principal $^5D_0$ state. For the purpose of comparison, the radial dependence of both these states is assumed to be (a) Gaussian and (b) Irving, whose parameters have been determined from a variational calculation of the binding energy of the α-particle using two-body potentials with or without velocity-dependence (or hard core). It is found that, of the two wave functions, only the Irving form gives results for the binding energy, the r.m.s. radius, and the muon-capture rate in the α-particle consistent with experiments and that too when a velocity-dependent (or hard core) potential is used. (auth)

19215 INELASTIC p-^{4}He SCATTERING AT 141 MeV. Nicholls, J. E.; Craig, A.; Griffith, T. C.; (and others) (University Coll., London). Nucl. Phys.; A181: No. 1, 329-36(1972).

Inelastic p-^{4}He scattering at 141 ± 2 MeV has been investigated with a high-pressure cloud chamber filled with helium. Results are presented for the total cross sections of each reaction channel and the neutron spectra for the p(^{4}He,pn)^{3}He reaction. (auth)

19216 MEASUREMENT OF THE ANALYSING POWERS iT_{11}, T_{20}, T_{21}, AND T_{22} IN ELASTIC DEUTERON-PROTON SCATTERING. White, R. E.; Grueebler, W.; Koenig, V.; (and others) (Eidgenoessisches Technische Hochschule, Zurich). Nucl. Phys.; A180: No. 2, 593-9(1972).

The analyzing powers iT_{11}, T_{20}, T_{21} and T_{22} for the elastic scattering of polarized deuterons by protons have been measured at deuteron energies of 6, 8, 10 and 11.5 MeV with the polarized deuteron beam from a tandem accelerator. The measurements cover the cm angular range from 40 to 155° and show small but non-zero analyzing powers at all energies. (auth)

19217 ENERGY DEPENDENCE OF QUASIFREE SCATTERING IN DEUTERON BREAKUP UNDER α-PARTICLE BOMBARDMENT FROM 30 TO 80 MeV. Allas, R. G.; Bonbright, D. I.; Bondelid, R. O.; (and others) (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 28: No. 9, 569-71(28 Feb 1972).

α-particle-induced quasi-free scattering in deuteron breakup exhibits no difference between kinematically equivalent α-p and α-n channels, in contrast to previously measured proton-induced breakup. This supports the hypothesis that spin and statistics play a dominant role in deuteron breakup reactions and that previously postulated charge and final-state effects cannot explain the proton data. (auth)

19218 PROTON DEUTERON ELASTIC SCATTERING AT HIGH ENERGY. Fukushima, Takao. Cleveland; Case Western Reserve Univ. (1971). 129p. University Microfilms Order No. 72-34.

Thesis.

Although high energy scattering of protons by nuclei has been studied for many years, only recently has the experimental technique been developed to allow the elastic scattering to be identified. In forward regions the Glauber theory seems to provide a practical means to calculate the elastic scattering theoretically. The present work is concerned with the proton-deuteron near-backward scattering, where the Glauber theory loses its validity because of small angle approximation and because the neglected baryon exchange mechanism plays an important role. Kerman and Kisslinger calculated the cross section using the first order exchange formula and found it smaller than the experiment. To explain the discrepancy they proposed the new structure of deuteron. In this work the second order correction to the simple first order process is calculated. It is found that the correction gives a significant amount of reduction to the first order calculation. Therefore the hope to explain the proton-deuteron backward peak solely by the conventional structure theory of deuteron seems to be further remote. Also, an estimate is given for the non-exchange process which is found to be negligible at backward angle. (Diss. Abstr. Int., B)

19219 TWO-NUCLEON INTERACTIONS, THE UNITARY MODEL, AND POLARIZATION IN ELASTIC NUCLEON-DEUTERON SCATTERING. Pieper, S. C.; Kowalski, K. L. (Case Western Reserve Univ., Cleveland). Phys. Rev., C; 5: No. 2, 306-23(Feb 1972).

The use of the first-order unitary model to calculate nucleon polarization in elastic nucleon-deuteron scattering at energies up to 40 MeV is investigated. One shortcoming of extant unitary-model calculations, that of inadequate two-nucleon input, is partially remedied by introducing a variety of more realistic models for the two-nucleon interaction. It is found that even with the latter interactions the unitary model fails to represent the nucleon polarization and, to a lesser degree, the elastic differential cross section. The nucleon polarization is found to be extremely sensitive, even at fairly low energies, to the presence of the P-wave components of the two-nucleon amplitudes when the three-particle scattering is computed via the unitary and other approximations. This indicates that any method (exact or otherwise) for computing polarizations in N-d scattering must include these components. 19 figures, 3 tables) (auth)

19220 SCATTERING OF POLARIZED 3-MeV NEUTRONS FROM ^{3}He. Hollandsworth, C. E.; Gilpatrick, M.; Bucher, W. P. (Army Ballistic Research Labs., Aberdeen Proving Ground, Md.). Phys. Rev., C; 5: No. 2, 395-9(Feb 1972).

Partially polarized 3-MeV neutrons were scattered from ^{3}He contained in a high-pressure gas scintillation cell. The resulting asymmetry in the elastic scattering was determined for seven scattering angles from 40 to 120° (lab). Time-of-flight techniques and neutron-γ-ray discrimination in the side detectors were used for background reduction. The measured asymmetry is small for angles less than 60° (lab) and reaches a maximum value at approximately 110° (c.m.). The maximum asymmetry determined from the present experiment corresponds to a polarization of +0.50. The differential polarization can be fitted within experimental uncertainties by assuming that d-wave effects are negligible. The principal features of the data are qualitatively reproduced by Dodder's reaction-matrix calculations, which use the Werntz-Meyerhof level parameters for ^{4}He. (4 figures, 1 table) (auth)

19221 KRAUSS-KOWALSKI CALCULATIONS OF NUCLEON-DEUTERON POLARIZATION. Aarons, J. C.; Sloan, Ian H. (Univ. of New South Wales, Kensington, Australia). Phys. Rev., C; 5: No. 2, 582-5(Feb 1972).

Nucleon-deuteron polarizations and differential cross sections were calculated in the energy range from 11 to 23 MeV, with exactly the same approximation (the unitary first-order approximation) and exactly the same interactions and parameters as in the recent calculations of Krauss and Kowalski. All the results are entirely different, however; in contrast to the previous results, the calculated polarizations are in complete disagreement with experiment. It is pointed out that the procedure used in the previous calculations of cutting off the partial-wave expansion at J = $\frac{3}{2}$ is unsatisfactory, but this observation does not explain the differences between the results at all. (6 figures) (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 18843, 19257, 19291, 19412, and 19449.

19222 (CEA-R-4252) STUDY OF THE REACTION ^{6}Li + ^{6}Li AT 2 MeV. Pornet, Jacqueline; Ulpat, Jean-Pierre (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Dec 1971. 22p. (In French). Dep. NTIS (U. S. Sales Only).

Nuclear reactions induced in ^{6}Li by ^{6}Li ions of 2 MeV were studied. The angular distributions of the protons emitted in the ^{6}Li(^{6}Li,p)^{11}B reaction were measured for seven proton groups, leading to various excited states of ^{11}B. The alpha spectra of the reaction ^{6}Li + ^{6}Li → 3α were transformed in the center of mass system and compared with the theoretical model of molecular break-up. (auth)

19223 REACTION (p,2p) ON LIGHT NUCLEI AT 50 MeV. Loshchakov, I. I.; Ostroumov, V. I.; Sadilin, A. E. (Leningrad Polytechnic Inst.). Yadern. Fiz.; 14: No. 4, 676-81(Oct 1971). (In Russian).

The reaction (p,2p) on C, O, and N nuclei was studied in an emulsion chamber exposed to 50 MeV protons under the total geometry. The integral cross section of the reaction is obtained averaged over these nuclei. The analysis of the reaction is carried out in framework of the impulse approximation applying the Treiman-Yang criterion. A conclusion is made on the possibility

of such a description for cases of small momentum transfers and the contribution of two-stage process (inelastic scattering of proton and excited nucleus decay with the emission of the second proton) is estimated. (auth)

19224 SPECTROSCOPY OF ^{14}N IN THE $^{12}C(t,n)$ REACTION. Cookson, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys.; A180: No. 1, 89-96(1972).

Angular distributions for the reaction $^{12}C(t,n)^{14}N$ feeding the 14 lowest states of ^{14}N have been measured at a triton energy of 8 MeV. These have been compared with the distributions calculated using double-stripping theory and wave functions for ^{12}C and ^{14}N given by True and by Cohen and Kurath. For most final states there is quite good agreement with the True level assignments although the 3.952 MeV state is fitted better by the Cohen and Kurath configuration. (auth)

19225 GAMMA-DECAY MODES OF ^{18}Ne. Gill, R. D.; Caraca, J. M. G.; Cox, A. J.; Rose, H. J. (Nuclear Physics Lab., Oxford). Nucl. Phys.; A180: No. 1, 79-88(1972).

The lifetimes of the 3376 and 3576 keV states in ^{18}Ne have been investigated by the Doppler-shift recoil-distance method using the $^{16}O(^3He,n)^{18}Ne$ reaction. The 3376 keV level has τ_m = 4.4 ± 0.6 ps and the 3576 keV level has τ_m < 6 ps. In addition the ground state branch of the 3616 keV level has been observed to be (12.5 ± 2.5)%. Furthermore it was found that $\delta(3616 \rightarrow 1887) = +0.03 \pm 0.09$. These results are compared with theoretical predictions. (auth)

19226 $^{14}N(\tau,p)^{16}O(g.s.)$ REACTION BETWEEN 7.9 AND 18.0 MeV. Bilaniuk, O. M. (Swarthmore Coll., Pa.); Fortune, H. T.; Garrett, J. D.; Middleton, R.; Alford, W. P. Nucl. Phys.; A180: No. 1, 69-78(1972).

Angular distributions of ground state protons from the $^{14}N(\tau,p)^{16}O$ reaction have been measured in the (laboratory) angular range 0° – 160° at $E(\tau)$ = 7.96, 8.60, 9.80 and 10.63 MeV and in the range 7.5° – 157.5° at $E(\tau)$ = 12.0, 14.0, 15.0 and 18.0 MeV. It is concluded that compound nucleus formation, or an intermediate process, dominates the reaction mechanism over most of the energy range investigated. At the higher energies, two-particle distorted-wave calculations have been performed, using standard optical-model parameters. Fits are reasonable only at forward angles, where the data indicate a dominant L = 2 contribution to the angular distribution. These fits favor the Cohen–Kurath description of the ^{14}N and ^{16}O ground states over that of Zuker, Buck and McGrory. (auth)

19227 APPLICATION OF THE K-HARMONICS METHOD TO CALCULATIONS OF EXCITED STATES OF ATOMIC NUCLEI. Grin, Yu. T.; Leinson, L. B. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 3, 536-44(Sep 1971). (In Russian).

Four-particle excitations in the nuclei ^{12}C and ^{16}O are calculated by means of the K-harmonics method. It is shown that the low-lying 0^+ state of the nuclei has an inner wave function corresponding to the four-particle excitation and may be satisfactorily described by only one (K_{min} + 4) harmonics. The rms radii, moments of inertia, quadrupole moments, and the deformation parameters of the nuclei are calculated, as well as the nucleon density and the shape of the nuclei ^{12}C and ^{16}O in the excited states. (2 figures, 3 tables) (auth)

19228 INVESTIGATION OF POLARIZATION OF THE PHOTOPROTONS FROM THE ^{12}C NUCLEUS AT THE γ-QUANTA ENERGY OF 550 TO 715 MeV. Goncharov, N. V.; Derebchinskii, A. I.; Zybalov, A. A.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 4, 673-5(Oct 1971). (In Russian).

Polarization of photoprotons from ^{12}C at photon energies from 550 up to 715 MeV was measured in the kinematical region of single pion photoproduction on free nucleons. The measured polarizations are compared with the quantities calculated assuming that in this region the protons are emitted as a result of reactions $\gamma + n \rightarrow \pi^- + p$ and $\gamma + p \rightarrow \pi^0 + p$ proceeding on the quasifree nucleons in the nucleus. Satisfactory agreement between the calculated values and the measured polarizations within the experimental accuracy provides evidence in favor of the dominance of the direct meson mechanism of interaction of photons with nuclei. (auth)

19229 MICROSCOPIC ANALYSIS OF $^{13}C(p,n)^{13}N_{gs}$, INCLUDING THE CORE POLARIZATION EXCHANGE PROCESS. Geramb, H. V. (Kernforschungsanlage, Juelich, Ger.). Phys. Lett.; 37B: No. 4, 351-4(13 Dec 1971).

The antisymmetrized DWBA formalism is employed in the analysis of the charge exchange reactions $^{13}C(p,n)^{13}N_{gs}$. The observed enhancement of this transition with respect to the pure valence process is explained by a second order core polarization exchange process. An excellent fit to the magnitude and shape of the cross section is obtained. The deformed potential model is used for the description of the core polarization. (auth)

19230 DEPENDENCE OF ^{16}O–^{16}O POTENTIAL ON THE DENSITY ANSATZ. Reichstein, I.; Malik, F. B. (Indiana Univ., Bloomington). Phys. Lett.; 37B: No. 4, 344-6(13 Dec 1971).

It is shown that the interior part of the $^{16}O-^{16}O$ potential depends critically on the ansatz prescribing the density of the compound system. (auth)

19231 STUDY OF THE REACTIONS $^{16}O(p,2p)^{15}N$, $^{12}C(p,2p)^{11}B$ AT 50 MeV. Hanna, A. M. (Queen's Univ., Belfast); Griffiths, R. J.; Clarke, N. M.; Squier, G. T. A. Phys. Lett.; 37B: No. 4, 361-2(13 Dec 1971).

Angular correlations for the reactions $^{16}O(p,2p)^{15}N$ and $^{12}C(p,2p)^{11}B$ have been measured at 49.5 MeV in a symmetric coplanar geometry. The results are compared with distorted wave impulse approximation predictions. (auth)

19232 SPINS OF THE ISOSPIN MIXED 5.61 AND 5.67 MeV LEVELS IN ^{18}F. Lindgren, R. A. (Ballistic Research Labs., Aberdeen Proving Ground, Md.); Young, F. C.; Cotton, B. Phys. Lett.; 37B: No. 4, 358-60(13 Dec 1971).

Collinear particle-particle angular correlation measurements for the $^{19}F(\tau,\alpha)^{18}F(\alpha)^{14}N$ reaction establish $J^\pi = 1^-$ for both the 5.61 and 5.67 MeV levels of ^{18}F. (auth)

19233 REACTION $^{12}C(d,^7Li)^7Be$ AS AN EXPERIMENTAL TEST OF THE BARSHAY–TEMMER ISOSPIN THEOREM. Young, J. C. (Chico State Coll., Calif.); Holman, A. B.; Slaus, I.; Cahill, T. A. Phys. Lett.; 37B: No. 4, 377-9(13 Dec 1971).

Asymmetries exceeding 20% have been observed in the $^{12}C(d,^7Li)^7Be$ cross section indicating that one or more of the conditions of the Barshay–Temmer theorem are violated. (auth)

19234 NUCLEAR POLARIZABILITY OF ^7Li FROM COULOMB EXCITATION. Haeusser, O. (Chalk River Nuclear Labs., Ont.); McDonald, A. B.; Alexander, T. K.; Ferguson, A. J.; Warner, R. E. Phys. Lett.; 38B: No. 2, 75-7(24 Jan 1972).

Excitation of the first excited state in ^7Li in the Coulomb and nuclear fields of ^{208}Pb was studied. Below $E(^7Li)$ = 24 MeV the polarizability of ^7Li was deduced to be $\alpha = 0.32 \pm 0.07$ fm^3. At higher energies a large backward cross section for α-particle production was observed; this reflects the prominent α–t cluster structure of ^7Li. (auth)

19235 COULOMB AND NUCLEAR STRUCTURE EFFECTS IN THE β-DECAYS OF ^{12}N AND ^{12}B. Laverne, A. (Institut des Sciences Nucleaires, Grenoble, France); Do Dang, G. Nucl. Phys.; A177: No. 2, 665-72(1971).

The decay rates of the ground states of ^{12}N and ^{12}B to the fundamental of ^{12}C are calculated. The ground-state wave functions are defined by a self-consistent Hartree–Fock calculation that takes account of the Coulomb interaction and the electromagnetic spin–orbit term. They are found to correspond to different deformations, and this leads to a difference in the ft values of 8.5%, an amount comparable to experimental results. (2 tables) (auth)

19236 PARITY OF THE 3134-keV, J = 1 STATE IN ^{18}F. Rolfs, C. (Univ. of Toronto). Z. Phys.; 249: No. 4, 312-20(1972).

The $^{16}O(^3He,p\gamma)^{18}F$ reaction at $E(^3He)$ = 2.95 MeV was used to study the low-lying states in ^{18}F below E_x = 3.2 MeV. A combination of γ-ray angular distribution and linear polarization measurements using a single planar Ge(Li) polarimeter resulted in a $J^\pi = 1^-$ assignment to the 3134-keV state. In addition, the positive-parity assignments to the $937(3^+)$ and $1702(1^+)$ keV states were verified. Information on branching and mixing ratios as well as on lifetimes is reported. The results are discussed in terms of the weak-coupling and strong-coupling models. (1 figure, 3 tables) (auth)

19237 LOW-ENERGY NEUTRON SCATTERING BY A HARTREE–FOCK FIELD. Dover, Carl B.; Nguyen van Giai (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A177: No. 2, 559-76(1971).

The effective interaction of Skyrme is applied to the calculation of neutron-scattering cross sections from ^{12}C, ^{16}O, and ^{40}Ca in the Hartree–Fock approximation. By using the same sets of force parameters which yield good results for the bound-state properties (binding energies, radii, etc.) of closed-shell nuclei, reasonable results are also found for the continuum properties of these nuclei. In particular, the position and width of the $d_{\frac{3}{2}}$ single-particle resonance in ^{17}O, as well as the differential cross section and polarization near the resonance, agree well with experimental values. (10 figures, 2 tables) (auth)

19238 ELASTIC SCATTERING OF DEUTERONS BY ^{9}Be FROM 1.00 TO 2.20 MeV. Lombaard, J. M.; Friedland, E. (Univ. of Pretoria). Z. Phys.; 249: No. 4, 349-55(1972).

The absolute differential cross section for the elastic scattering of deuterons by beryllium was investigated for incident energies from 1.0 to 2.2 MeV. An excitation curve measured at 90° (lab) showed no sharp resonances. The ratio of the differential cross section to that predicted by Rutherford's formula was found to increase gradually with energy. Angular distributions from 40° to 160° were measured in 200-keV steps from 1.0 to 2.2 MeV, and optical-model analyses of these data were made. Good fits were obtained with a volume-absorption potential with a real well depth in the region of 20 MeV. (5 figures, 1 table) (auth)

19239 MEASUREMENT OF THE ISOSPIN PURITY OF THE SINGLET DEUTERON. Braithwaite, W. J. (Univ. of Washington, Seattle); Cameron, J. M.; Cramer, J. G.; Rudy, C. R.; Eidson, W. W. Phys. Lett.; 38B: No. 2, 67-9(24 Jan 1972).

The isospin-selective ^{6}Li(d,pn) reaction shows spectral peaking (characteristic of $^{1}S_0$) for the 3.56-MeV (T = 1) state, in contrast to the much broader spectral shape (characteristic of $^{3}S_1$) seen for the (T = 0) ground state and 2.18-MeV state of ^{6}Li. (auth)

19240 PRE-EQUILIBRIUM CHARGE STATE STUDY OF BORON IONS FROM THE ^{12}C(d,α)^{10}B REACTION IN ELEMENTAL CARBON. Sorbo, Roger Allan. Pittsburgh; Univ. of Pittsburgh, (1971). 70p. University Microfilms Order No. 71-23,660.

Thesis.

Charge state distributions of boron recoils from the ^{12}C(d,α)^{10}B reaction have been measured at a velocity of 1.11×10^{9} cm/sec in elemental carbon targets of from 0.15 to 91 μg/cm^2 in thickness. The experimentally determined charge state abundances and mean charges from targets thicker than about 15 μg/cm^2 exhibit equilibrium behavior, while those from targets thinner than 15 μg/cm^2 exhibit a pre-equilibrium behavior. In all the targets except the thinnest, the $^{10}B^{4+}$ charge state predominated. In the thinnest target, however, an abrupt change in the charge state abundances occurred, the $^{10}B^{3+}$ charge state becoming most abundant. Of the processes which may be taking place during the nuclear reaction, only the emission of an alpha particle has been treated theoretically. Using this limited theoretical approach, which applies the adiabatic approximation to the case of alpha decay, instantaneous charge state distributions were calculated and compared with the measured charge state distribution from the thinnest target. The calculated and measured charge state distributions were in gross disagreement, the calculation predicting predominant instantaneous charge states of 0, 1+, and 2+, whereas the only observed charge states were 3+, 4+, and 5+. It is concluded that other processes, such as transit through the electron cloud by the incoming deuteron and the nuclear charge change from 6+ to 7+ to 5+, are at least partly responsible for the higher charge states which are observed. (Diss. Abstr. Int., B)

19241 NEW SEARCH FOR RESCATTERING EFFECTS IN THE ^{7}Li + d $\rightarrow$ α + α + n REACTION. Bray, K. H.; Cameron, J. M.; Neilson, G. C.; Sharma, T. C. (Univ. of Alberta, Edmonton). Nucl. Phys.; A181: No. 1, 319-28(1972).

Rescattering effects in the ^{7}Li(d,$\alpha\alpha$)n reaction are re-examined at incident deuteron energies between 1.90 and 2.10 MeV. The previously reported effects attributed to rescattering following the formation of the resonance state at 16.63 MeV in ^{8}Be are not observed. Conditions affecting the observation of such a rescattering are discussed. (auth)

19242 THREE-ALPHA-DECAY MECHANISM OF HIGHER EXCITED STATES OF ^{12}C IN THE REACTION ^{11}B(p,3α). Yamane, Isao (Kyoto Univ.). Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem.; 33: No. 3, 281-309 (Mar 1971).

The three-α-decay mechanism of higher excited states of ^{12}C is investigated in the reaction ^{11}B(p,3α) to obtain information about the structure of those states. Coincidence measurements are carried out under the detection condition devised to distinguish between the sequential decay and the direct three α decay. Dependences of energy spectra of coincident α particles upon the incident energy and the angle are measured between 138 keV and 232 keV and between 2.00 MeV and 5.30 MeV of the incident energy. The spectra show strong dependence upon the resonances. At the 163 keV (16.11 MeV in ^{12}C; 2^+, T = 1), the 2.62 MeV (18.36 MeV; 3^-, T = 0), the 3.75 MeV (19.4 MeV; 2^+, T = 0) and the 5.10 MeV (20.64 MeV; 3^-, T = 1) resonances the spectra suggest the direct three α decay. Around 215 keV and 2.4 MeV, and at the 3.5 MeV (19.2 MeV; 1^-, T = 1) and the 4.92 MeV (20.47 MeV) resonances, they suggest the sequential decay. The direct-three-α-decay states are considered to have some "α cluster structures." (auth) (Japan)

19243 STUDY OF THE ^{9}Be(^{3}He,$\alpha\alpha$)^{4}He REACTION. Taylor, M. C.; Valkovic, V.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys.; A182: No. 3, 558-70(1972).

The three α-particle final state from the reaction ^{9}Be(^{3}He,$\alpha\alpha$)^{4}He has been studied at ^{3}He bombarding energies of 3 and 4 MeV. Two α-particles were detected in coincidence in order to obtain the angular correlations between the first-emitted α-particle and the break-up α-particles from the recoil ^{5}Be* system. The angular correlation data are compared with a generalized density-of-states calculation. Good fits to the data are obtained when the relative angular momenta of the detected particles are included in the calculation. (auth)

19244 POLARIZATION OF NEUTRONS FROM ^{10}B + d, ^{11}B + d AND ^{13}C + d REACTIONS. Meier, M. M.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C. Nucl. Phys.; A182: No. 3, 468-80(1972).

Polarization angular distributions have been obtained for neutrons from (d,n) reactions on ^{10}B, ^{11}B and ^{13}C in about 300 keV steps from approximately 2.7 to 3.9 MeV. Nearly constant angular dependences were observed for most of the reactions suggesting that a direct-reaction mechanism predominates. A large difference between distributions for the j = $^3/_2$ ^{11}B(d,n$_0$) and the j = $^1/_2$ ^{11}B(d,n$_1$) is exhibited. For the low Q-value reactions, i.e., for the ^{10}B and ^{13}C targets, large negative polarizations were observed at forward angles for $p_{\frac{1}{2}}$ transfer reaction whereas positive or slightly negative values were seen for $p_{\frac{3}{2}}$ transfer reactions. Comparisons to DWBA calculations are made for deuteron parameters previously derived. (auth)

19245 TWO-NEUTRON TRANSFER REACTIONS (^{18}O,^{16}O) WITH ^{18}O, ^{14}C, AND ^{26}Mg TARGETS. Eyal, Y.; Dostrovsky, I.; Fraenkel, Z. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A180: No. 2, 545-68(1972).

Excitation functions, angular distributions and differential ranges were measured for the ^{26}Mg(^{18}O,^{16}O)^{28}Mg reaction at ^{18}O beam energies of 20 to 45 MeV. Excitation functions only were measured for the reactions ^{14}C(^{18}O,^{19}O)^{13}C, ^{14}C(^{18}O,^{16}O)^{16}C, ^{14}C(^{18}O,^{20}O)^{12}C, ^{14}C(^{18}O,^{15}N)^{17}N and ^{18}O(^{18}O,^{19}O)^{17}O, ^{18}O(^{18}O,^{16}O)^{20}O, ^{18}O(^{18}O,^{15}N)^{21}F at ^{18}O beam energies of 13 to 41 MeV. These were identified as direct reactions in which a single neutron, a two-neutron cluster, a deuteron and a triton are transferred between projectile and target. The cross sections for two-neutron transfer reactions were found to be relatively high and those for the ^{18}O + ^{18}O and the ^{14}C + ^{18}O reactions were higher than the ones of single-neutron transfers over most of the energy range. Attempts were made to apply the theory of Buttle and Goldfarb for single-neutron transfer to the case of two-neutron transfer in the ^{26}Mg(^{18}O,^{16}O)^{28}Mg reaction below the Coulomb barrier. It is shown that for those reactions for which the assumptions, implicit in the model, are valid, good agreement is obtained with experiment. Also an attempt was made to apply the diffraction model of Dar and Kozlovsky to the calculation of the angular distribution of these reactions. A good fit to the experimental results could be obtained if quite different sets of parameters were used in the calculations for the two bombarding energies. (auth)

19246 STRUCTURE OF MASS 15: THE ^{14}N(p,γ^{15}O AND ^{14}N (p,p'γ) REACTIONS. Phillips, G. W.; Richard, Patrick; Elliott, D. O.; Hopkins, F. F.; Porter, A. C. (Univ. of Texas, Austin). Phys. Rev., C; 5: No. 2, 297-306(Feb 1972).

States in ^{15}O between 10.91 and 13.02 MeV excitation were studied as resonances in the ^{14}N(p,γ)^{15}O and ^{14}N(p,p'γ) reactions. Several new states are reported, and the elastic, inelastic, and γ-ray partial widths are given for some of the levels. The levels are compared with corresponding levels in the mirror nucleus ^{15}N. Of particular interest are the $^1/_2^+$ and $^5/_2^+$, T = $^3/_2$ states which should lie in this region. The results imply more mixing of these states in ^{15}O with nearby T = $^1/_2$ levels than is observed in ^{15}N. However, most of the T = $^3/_2$ strength in ^{15}O remains unaccounted for. (7 figures, 4 tables) (auth)

19247 STUDY OF THE 2p–1h STRUCTURE OF ^{17}O VIA THE ^{15}N(^{3}He,p) REACTION. Lemaire, M.-C. (CEN de Saclay, Gif-sur-Yvette, France); Mermaz, M. C.; Seth, Kamal K. Phys. Rev., C; 5: No. 2, 328-50(Feb 1972).

The double-stripping reaction ^{15}N(^{3}He,p)^{17}O was studied with a magnetic spectrograph at an incident ^{3}He energy of 18 MeV with an energy resolution of about 30 keV. Differential cross sections were measured for transitions to states in ^{17}O up to an excitation energy of 11 MeV. The data were analyzed in the distorted-wave Born approximation using the Glendenning formalism and the multishell shell-model wave functions of Zuker, Buck, and McGrory

for states in ^{17}O. The model wave functions are found to fit the data quite well for a number of low-lying states; however, several exceptions are also found. (15 figures, 7 tables) (auth)

19248 PHENOMENOLOGICAL ANALYSIS OF THE ^{12}C + ^{12}C REACTION. Michaud, Georges J. (Univ. of Montreal); Vogt, Erich W. Phys. Rev., C; 5: No. 2, 350-68(Feb 1972).

The total ^{12}C + ^{12}C low-energy reaction cross section was reanalyzed. Three phenomena suggest an α-particle model for the reaction: the giant resonances, the intermediate-structure resonances, and anomalous branching ratios. The energy dependence of the total cross section over the energy range 2.4 to 9.0 MeV cannot be explained solely by the energy dependence of the penetration of the Coulomb barrier. There is some nuclear structure. The structure can be explained by an optical potential based on the α model leading to absorption under the barrier. It could also be explained with two giant resonances in a Woods–Saxon potential. The intermediate structure is explained as due to special states of ^{24}Mg built of a ^{12}C core and three α particles, and so are the anomalous branching ratios. Astrophysical reaction rates were calculated for a number of possible optical potentials. The giant resonances affect the extrapolation to the energies of astrophysical interest and lead to an uncertainty of a factor of 3 to 10 in the astrophysical reaction rate at $T_9 \simeq 0.6$, where $T_9 \equiv 10^{-9}T°K$. (13 figures, 2 tables) (auth)

19249 γ-RAY DECAY OF THE 15.11-MeV T = 1 STATE OF ^{12}C. Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.); Wilkinson, D. H. Phys. Rev., C; 5: No. 2, 384-90(Feb 1972).

The reaction $^{10}B(^3He,p)^{12}C$ at $E_{^3He}$ = 2.2 MeV was used to investigate the γ decay of states in ^{12}C. The γ-ray spectrum from a NaI(Tl) detector in coincidence with protons leading to the 15.11-MeV state of ^{12}C exhibits transitions of 2.38 ± 0.02, 4.44, 7.48 ± 0.03, 10.71 ± 0.05, and 15.11 MeV. Relative γ-ray branches from the 15.11-MeV state to the 12.71-, 7.65-, and 4.44-MeV, and ground states are (1.4 ± 0.4), (2.6 ± 0.7), (2.3 ± 0.9), and (92 ± 2)%, respectively, where an allowance of 1.6% was made for a possible but unobserved 15.11 → 10.3 transition. Also observed were γ-ray branches of (15 ± 4) and (85 ± 4)% from the 12.71-MeV state of ^{12}C to the 4.44-MeV and ground states, respectively. γ-branching intensities from the 15.11-MeV state are compared with the corresponding β-transition rates of ^{12}N and ^{12}B to these same states of ^{12}C, and the conclusions about the orbital contribution to the M1 γ-ray transition strength are compared with shell-model expectations. Previously reported evidence for an isospin-forbidden α-decay branch from the 15.11-MeV level is discussed in the light of the present results. (3 figures, 2 tables) (auth)

19250 ELASTIC ELECTRON SCATTERING FROM ^6Li AND ^7Li AT LOW MOMENTUM TRANSFER. Bumiller, F. A. (Naval Postgraduate School, Monterey, Calif.); Buskirk, F. R.; Dyer, J. N.; Monson, W. A. Phys. Rev., C; 5: No. 2, 391-5(Feb 1972).

Elastic electron scattering experiments were performed on ^6Li and ^7Li at momentum transfers less than 1 F^{-1}. Charge form factors are reported, and model-independent as well as model-dependent rms radii are calculated. The model-independent radii for ^6Li and ^7Li are 2.51 ± 0.10 and 2.35 ± 0.10 F, respectively. (2 figures, 3 tables) (auth)

19251 PION–NUCLEUS INTERACTION IN THE (3,3)-RESONANCE REGION. Faeldt, Goeran (Harvard Univ., Cambridge, Mass.). Phys. Rev., C; 5: No. 2, 400-12(Feb 1972).

Current theoretical models for the pion–nucleon interaction in the (3,3)-resonance region are discussed. Nonlocal potentials of the Kisslinger type are inadequate. The most promising potential is local and closely related to the Glauber model. Some properties of the Glauber model are also studied. Thus it is shown that the multiple-scattering series can be summed and charge-exchange effects can easily be taken into account. (5 figures) (auth)

19252 IDENTIFICATION OF MEDIUM-ENERGY α-PARTICLE-INDUCED REACTIONS ON THE LIGHT EMULSION NUCLEI. Jung, M.; Baixeras-Aiguabella, C.; Jacquot, C.; Girardin, L.; Schmitt, R. (Centre de Recherches Nucleaires, Strasbourg). Phys. Rev., C; 5: No. 2, 579-82(Feb 1972).

After a short survey of the technique of using an emulsion simultaneously as target and detector for medium-energy-induced reactions with the light nuclei C, N, and O, two important points relating to previous results given for 70-MeV and 90-MeV α-particle reactions are discussed: first, the possibility of losing events and, secondly, the possibility of wrongly identifying an event. (2 figures, 1 table) (auth)

19253 ADIABATIC DEUTERON MODEL AND THE $^{16}O(p,d)$ REACTION. Preedom, B. M. (Univ. of South Carolina, Columbia. Michigan State Univ., East Lansing). Phys. Rev., C; 5: No. 2, 587-93(Feb 1972).

Distorted-wave calculations using the Johnson and Soper adiabatic deuteron potential were carried out for the reaction $^{16}O(p,d)$ ^{15}O at 31.82, 38.63, and 45.34 MeV. The calculated angular distributions describe the data well with no need for a lower radial cutoff. The resultant spectroscopic factors are plausible and relatively independent of energy. Various modifications of the distorted-wave calculations and the sensitivity to different proton and deuteron potentials are investigated. (3 figures, 3 tables) (auth)

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Refer also to abstracts 17806, 18478, 19245, 19283, 19291, 19336, 19592, and 19594.

19254 (PH–9) GAMMA RAYS FROM THERMAL NEUTRON CAPTURE IN ^{30}Si AND ^{34}S. Jafar, J. D.; Abdulla, A. A.; Al-Quraishi, N. H.; Alwash, M. S.; Khalil, M. A.; Demidov, A. M. (Atomic Energy Commission, Baghdad (Iraq). Nuclear Research Inst.,). 1970. 15p. Dep. NTIS (U. S. Sales Only).

Gamma radiation from the reactions $^{30}Si(n,\gamma)^{31}Si$ and $^{34}S(n,\gamma)^{35}S$ was measured with a Ge(Li) spectrometer. All the observed γ transitions can be placed in the decay schemes of ^{31}Si and ^{35}S except the 4093-keV transition in ^{31}Si. The neutron binding energy is 6588.4 ± 0.3 and 6986.4 ± 0.3 keV for ^{31}Si and ^{35}S, respectively. (auth)

19255 ENCHANCEMENT OF DEUTERON TRANSFER REACTIONS BY NEUTRON–PROTON PAIRING CORRELATIONS. Froebrich, P. (Technische Univ., Munich,). Phys. Lett.; 37B: No. 4, 338-40(13 Dec 1971).

It is shown for $^{36}Ar(p,^3He)^{34}Cl$ that the transfer of a neutron–proton pair is enhanced as compared to the shell model if one takes into account T = 0 and T = 1 neutron–proton pairing correlations in the description of target and residual nucleus. (auth)

19256 STUDY OF ^{23}Na. Lindgren, R. A.; Hirko, R. G.; Pronko, J. G.; (and others) (Yale Univ., New Haven). Nucl. Phys.; A180: No. 1, 1-18(1972).

Levels extending up to 6.58 MeV excitation in ^{23}Na have been studied using the $^{26}Mg(p,\alpha\gamma)$ and $^{23}Na(\alpha,\alpha'\gamma)$ reactions. The analysis of the particle-γ angular-correlation data yielded information on the spin, branching and mixing ratio for transitions in ^{23}Na. When combined with lifetime and direct reaction data, unique J^π = $\frac{1}{2}^-$ and $\frac{5}{2}^-$ assignments were obtained for the 2.64 and 3.85 MeV levels, respectively, in ^{23}Na. Spin limitations were imposed on other levels, notably the 5.54, 5.74, 6.24 and 6.58 MeV levels. An interpretation of the 5.54 and 6.24 MeV levels as the J^π = $\frac{11}{2}^+$ and J^π = $\frac{13}{2}^+$ ground state rotational band members is given. The electric dipole transition strengths of the lowest J^π = $\frac{1}{2}^-$, $\frac{3}{2}^-$ and $\frac{5}{2}^-$ levels are discussed in terms of the K^π = $\frac{1}{2}^-$ Nilsson rotational band based on orbit no. 4 and in terms of first-order angular-momentum corrections to the electric dipole matrix elements. (auth)

19257 NEUTRON YIELD FROM μ CAPTURE IN O, S, Ca, AND Pb. Voitkovska, I.; Evseev, V. S.; Kozlovski, T.; Mamedov, T. N.; Roganov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 3, 624-9(Sep 1971). (In Russian).

Neutron absolute yield (per μ-capture event) was measured for μ capture in oxygen in the energy interval from 2.5 to 7.5 MeV: $\bar{n}$ = 0.526 ± 0.068; in sulfur, from 1.5 up to 10 MeV: $\bar{n}$ = 0.414 ± 0.035; in calcium, from 2 up to 10 MeV: $\bar{n}$ = 0.263 ± 0.033; and in lead, from 2 up to 7 MeV: $\bar{n}$ = 0.536 ± 0.031. In the case of oxygen there is a quantitative agreement between the obtained neutron yield and predictions of the resonance model for nuclear μ capture. (2 figures, 1 table) (auth)

19258 β-DELAYED PROTON EMISSION OF ^{23}Al. Gough, R. A.; Sextro, R. G.; Cerny, Joseph (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 8, 510-12(21 Feb 1972).

The weak β-delayed proton emitter ^{23}Al, with a half-life of 470 ± 30 ms, was produced by the reaction $^{24}Mg(p,2n)^{23}Al$. Delayed protons with a center-of-mass energy of 870 ± 30 keV and a maximum production cross section ≈220 nb were observed. (auth)

19259 HALF-LIFE OF ^{28}Al. Van Schandevijl, R.; Van Grieken, R.; Hoste, J. (Univ., Ghent). J. Radioanal. Chem.; 9: No. 1, 55-60(Oct 1971).

The half-life of ^{28}Al was redetermined on aluminum samples of different origin. Three different counting techniques were applied.

The availability of highly purified samples (up to 99.9999%), the use of very fast electronic counting equipment and a complete automatization allowed a good precision to be obtained in the final result of 2.2405 min. (auth)

19260 LIFETIMES AND DECAY MODES OF ENERGY LEVELS IN ^{23}Na, ^{26}Mg, AND ^{26}Al. Durell, J. L.; Alderson, P. R.; Bailey, D. C.; (and others) (Univ. of Liverpool). J. Phys., A (London); 5: No. 2, 302-17(Feb 1972).

The mean lifetimes of levels in ^{23}Na, ^{26}Mg and ^{26}Al were determined by the Doppler shift attenuation method. The levels were populated by the reactions ^{23}Na(p,p')^{23}Na, ^{23}Na(α,p)^{26}Mg and ^{23}Na(α,n)^{26}Al at proton bombarding energies between 3.6 and 7.0 MeV and α particle energies between 4.6 and 7.5 MeV. The γ rays were detected using a Ge(Li)-NaI(Tl) anti-Compton and pair spectrometer. A discussion of the rotational band structure of the levels in ^{23}Na below 5 MeV is given. The results for ^{26}Mg and ^{26}Al are compared with other recent determinations. (auth)

19261 LIFETIMES OF LEVELS IN ^{38}Ar. Ball, G. C.; Davies, W. G.; Forster, J. S.; James, A. N.; Ward, D. (Chalk River Nuclear Labs., Ont.). Nucl. Phys.; A182: No. 3, 529-40 (1972).

The mean lifetimes of the $J^\pi = 0^+$ and 5^- levels in ^{38}Ar at 3377 and 4585 keV have been measured to be 34 ± 5 ps and 196 ± 10 ps, respectively, using a coincidence recoil-distance Doppler-shift method and the ^{35}Cl(α,pγ)^{38}Ar reaction. The lifetime of the 4^- level at 4480 keV excitation was measured to be $1.6^{+1.1}_{-0.4}$ ps by the Doppler-shift attenuation method. All three lifetimes are significantly longer than recent theoretical predictions. (auth)

19262 CIRCULAR POLARIZATION OF NEUTRON CAPTURE γ-RAYS FROM Al, Ar, AND Ca. Stecher-Rasmussen, F.; Abrahams, K.; Kopecky, J. (Reactor Centrum Nederland, Petten). Nucl. Phys.; A181: No. 1, 225-40(1972).

Measurements of the circular polarization of γ-rays from the capture of polarized thermal neutrons in natural Al, Ar and Ca result in new spin assignments to the following bound states: ^{28}Al(3.47 MeV), $J^\pi = 4^-$; ^{28}Al(3.59), $J^\pi = 4^-(2)^-$; ^{41}Ar(2.95), $J^\pi = 3/2^-$; ^{41}Ca(4.78), $J^\pi = 3/2^-$. The ^{41}Ca levels at 3.61 and 4.75 MeV, for which conflicting spin values have been reported previously, both have $J^\pi = 1/2^-$. The spins of 10 other bound states are confirmed. The M1 + E2 ground state transition from the capturing state in ^{28}Al has an amplitude mixing ratio of $\delta = +1.00 \pm 0.14$. (auth)

19263 (n,α) AND (n,p) REACTIONS IN SILICON AND THE (n,p) REACTION IN ALUMINUM AT ENERGIES UP TO 5.6 MeV. Robertson, J. C.; Zieba, K. J. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy; 26: No. 1, 1-8(Jan 1972).

Cross sections are given for the (n,p) and (n,α) reactions in silicon and the (n,p) reaction in aluminum at energies up to 5.6 MeV. The silicon measurements were made using a silicon semiconductor detector as the target and detector, and the aluminum measurements were made by β-counting the ^{27}Mg activity produced in aluminum foils. The results are compared with previous measurements. It is shown that in measuring excitation functions in this energy region, the use of a silicon semiconductor detector is a convenient method of measuring the incident neutron energy. (auth)

19264 PHOTONUCLEAR REACTIONS LEADING TO ^{24}Na AND ^{28}Mg. Saito, Tatsuya (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 44: No. 7, 1800-7(Jul 1971).

The photonuclear reaction yields of ^{24}Na and ^{28}Mg in magnesium, aluminum, silicon, phosphorus, and sulfur were obtained at energies between 20 MeV and 250 MeV by the induced radioactivity method. The ^{12}C(γ,n)^{11}C yield was used as a standard for the beam monitor. The excitation curves of the ^{27}Al → ^{24}Na, ^{28}Si → ^{24}Na, ^{28}Si → ^{28}Mg, ^{31}P → ^{24}Na, ^{31}P → ^{28}Mg, ^{32}S → ^{24}Na, and ^{32}S → ^{28}Mg reactions were obtained from the yields by the photon-difference method. Each of these excitation functions indicates a peak in the 50 to 70 MeV energy range, except in the case of the sulfur target, in which the peak is due to the contribution from the compound-nucleus process. The interaction of photons with nuclei at photon energies exceeding the peak energy region probably does not lead to the formation of the compound nucleus. In the energy range from 70 MeV up to 150 MeV, the cross sections are due to the contribution from the quasi-deuteron process. At energies above 150 MeV and up to 250 MeV, the quasi-deuteron and pion production processes compete. In the high-energy photonuclear reaction mechanisms, the quasi-deuteron and pion production processes must be considered at the initial cascade process, but the evaporation process may be considered after the cascade process. (auth)

19265 TENSOR POLARIZATION AND DIFFERENTIAL CROSS SECTIONS FOR THE ELASTIC SCATTERING OF DEUTERONS BY Si AT LOW ENERGIES. Djaloeis, A.; Nurzynski, J. (Australian National Univ., Canberra). Nucl. Phys.; A181: No. 1, 280-8(1972).

The angular dependence of the three components T_{20}, T_{21} and T_{22} of the tensor polarization of deuterons from Si(d,d)Si elastic scattering has been measured. The energy of the projectiles was 7 MeV, and the scattering angles were between 15° and 90° (lab) in steps of 7.5°. The experimental data were analyzed using the optical model without and with the inclusion of the Hauser-Feshbach correction. The addition of small, attractive and long-ranged tensor interaction T_R to the central and spin-orbit forces was found necessary to account for the observed features of the tensor polarization. (auth)

19266 GAMMA-RAY ANGULAR DISTRIBUTIONS IN THE ^{30}Si(α,nγ)^{33}S REACTION. Toulemonde, M.; Schulz, N. (Laboratoire de Physique du Noyau et de Physique des Particules, Strasbourg). Nucl. Phys.; A181: No. 1, 273-9(1972).

Gamma-ray angular distributions in the ^{30}Si(α,nγ) reaction have been used to study the multipole mixing ratios of transitions between the low-lying levels in ^{33}S. Incident ^{4}He energies were chosen close to the threshold to restrict the population of the possible substates. The results are examined with regard to theoretical predictions. (auth)

19267 E1 DECAY OF MEMBERS OF THE LOW-LYING $K^\pi = 1/2^-$ BAND IN ^{23}Na. Frank, G. G.; Greene, M. W.; Kelly, D. T.; Pilt, A. A.; Kuehner, J. A. (McMaster Univ., Hamilton, Ont.). Phys. Rev. Lett.; 28: No. 9, 571-4(28 Feb 1972).

A state at $E_x = 6.350$ MeV in ^{23}Na is shown to have $J^\pi = 9/2^-$ and is assigned to the rotational band based on the $1/2^-$ state at 2.640 MeV. Its γ-ray decay lifetime and branching ratios are determined and combined with known information about the proposed $J = 1/2$ to $7/2$ members of this band to show that there is an anomalous E1 decay pattern between the members of this band and the members of the ground-state band. This anomalous pattern can be explained using the Nilsson model with band mixing. (auth)

19268 ^{20}Ne(d,p)^{21}Ne REACTION AT LOW DEUTERON ENERGIES. Comsan, M. N. H.; El-Behay, A. Z.; Farouk, M. A. (Atomic Energy Establishment, Cairo). Atomkernenergie; 18: No. 4, 317-20(1971).

Angular distributions and excitation functions of proton groups emitted from the reaction ^{20}Ne(d,p) ^{21}Ne and leading to the ground and the first two excited states have been studied in the deuteron energy range from 0.9 to 2.4 MeV. Intensive maxima are observed at certain deuteron energies in the excitation functions of the studied proton groups. Angular distributions show contributions from both compound nucleus formation and direct processes. A level in the compound nucleus ^{22}Na is predicted at $E_x = 12.92$ MeV and is supposed to have $J^\pi = 3^+$. (auth)

19269 LIFETIMES OF LOWER EXCITED STATES IN ^{27}Si. Bini, M.; Bizzeti, P. G.; Bizzeti-Sona, A. M. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cim.; 6A: No. 4, 543-52(21 Dec 1971).

The mean lives of some levels in ^{27}Si have been measured with the Doppler-shift attenuation method by means of the ^{28}Si(^{3}He, α)^{27}Si reaction. The γ-rays were detected in coincidence with alphas at the angle $\theta = 60°$. The results for the mean lives are the following: $\tau_m = (1.8 \pm 0.6)$ ps, $(65^{+\infty}_{+30})$ fs, >5 ps and <63 fs for the 0.957, 2.162, 0.781 and 2.647 MeV levels, respectively. (auth)

19270 (p,t) REACTION ON EVEN-EVEN N = Z NUCLEI IN THE 2s1d SHELL. Paddock, R. A. (Michigan State Univ., East Lansing). Phys. Rev., C; 5: No. 2, 485-500(Feb 1972).

The (p,t) reaction on the even-even N = Z nuclei in the 2s1d shell was used to study the energy levels of ^{18}Ne, ^{22}Mg, ^{26}Si, ^{30}S, ^{34}Ar, and ^{38}Ca. The energies of the excited states observed are reported along with spin and parity assignments when possible. Two-nucleon-transfer distorted-wave calculations were carried out. Comparisons are made with the shapes of the experimental angular distributions. It is found that the calculated shapes are primarily dependent upon the l transfer and the optical-model parameters. The magnitudes of the calculated cross sections are found to depend strongly, not only on the optical-model parameters, but also the bound-state parameters and the configuration mixing in the initial and final nuclear wave functions. (13 figures, 7 tables) (auth)

19271 SINGLE-PARTICLE STRENGTHS FOR QUASIBOUND LEVELS IN ^{33}Cl. Kozub, R. L.; Youngblood, D. H. (Texas A and M Univ., College Station). Phys. Rev., C; 5: No. 2, 413-19(Feb 1972).

The reaction ^{32}S(^{3}He,d)^{33}Cl was studied at bombarding energies of 29.7 and 34.5 MeV. Angular distributions measured for levels

up to 8.7 MeV excitation were analyzed with the distorted-wave Born approximation; a resonance-form-factor technique developed previously was utilized for the quasi-bound levels. The resulting spectroscopic factors are compared with the 15-MeV (^{3}He,d) results of Morrison, with values deduced from elastic scattering widths, and with recent theoretical calculations. Significant disagreements with the 15-MeV results are observed for the ground state ($l_p = 2$) and 2.69-MeV level ($l_p = 3$), while reasonable agreement with the elastic scattering results are observed for $l_p = 3$ levels of higher excitation. (5 figures, 3 tables) (auth)

19272 STUDY OF THE LOW-LYING STATES OF ^{38}Cl VIA THE REACTION ^{37}Cl(d,pγ)^{37}Cl. Engelbertink, G. A. P.; Olness, J. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 5: No. 2, 431-45(Feb 1972).

Levels of ^{38}Cl below an excitation energy of 2.75 MeV were studied with the reaction ^{37}Cl(d,pγ)^{38}Cl at a deuteron bombarding energy of 3.1 MeV. γ-ray branching ratios and Doppler-shift information were obtained from proton–γ coincidence measurements using $BaCl_2$ targets enriched in ^{37}Cl. Excitation energies were determined from singles measurements, as well as from the coincidence studies for the 10 levels previously reported in this energy range. The $J^\pi = 1^+$ level at 1942 keV, which is strongly excited in the β decay of ^{38}S and which was not observed in ^{37}Cl(d,p) ^{38}Cl studies with a magnetic spectrograph, is also weakly populated. Excitation energies (in keV) and mean lives (in ps) for the lowest 10 levels are 671.27 ± 0.16; 755.26 ± 0.11, 0.53 ± 0.18; 1308.87 ± 0.14, $1.0^{+0.3}_{-0.2}$; 1617.21 ± 0.14, $2.3^{+0.3}_{-0.3}$; 1692.4 ± 0.2, 1.9 ± 0.7; 1745.8 ± 0.3, $2.1^{+1.1}_{-0.7}$; 1785.1 ± 0.5, 0.09 ± 0.03; 1941.7 ± 0.2; 1981.11 ± 0.15, 0.43 ± 0.09; and 2743.1 ± 0.4, ≤0.03. The multipole strengths of the transitions linking these states with the 2^- ground state and 5^- first excited state lead, in combination with the l_n transfer values from previous (d,p) work, to the following spin–parity assignments: $J^\pi(755) = 3^-$; $J^\pi(1309) = 4^-$; $J^\pi(1617) = 3^-$; $J^\pi(1692) = 1^-$, 2^-, or 3^-; $J^\pi(1785) = 2^+$, 3^+, or 4^+; $J^\pi(1981) = 2^-$ or 3^-; and $J^\pi(2743) = 3^-$. The experimental results are compared with shell-model calculations and with predictions from the Pandya transformation of the known $(\pi 1d_{\frac{3}{2}})^{-1}(\nu 1f_{\frac{7}{2}})$ and $(\pi 1d_{\frac{3}{2}})^{-1}(\nu 2p_{\frac{3}{2}})$ quadruplets in ^{40}K. (14 figures, 6 tables) (auth)

19273 ANGULAR-CORRELATION STUDY OF ^{27}Si BETWEEN $E_x = 2.5$ AND $E_x = 5$ MeV USING THE REACTION ^{28}Si(^{3}He,$\alpha\gamma$)^{27}Si. Balamuth, D. P.; Holden, J. E.; Zurmuehle, R. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 5: No. 2, 476-84 (Feb 1972).

Angular correlations and branching ratios were measured for the 2.65-, 2.86-, 2.91-, 4.14-, and 4.30-MeV states in ^{27}Si. When combined with the known lifetimes, the results exclude spins $^7/_2$ and $^9/_2$ for the 2.86-MeV state and spin $^3/_2$ for the 2.91-MeV state; the branching ratios suggest that the 2.86- and 2.91-MeV states are the mirrors of states at 2.98 and 3.00 MeV in ^{27}Al. The 4.30-MeV state is assigned $J^\pi = {}^5/_2{}^+$; its decay scheme is very similar to that of the 4.41-MeV state in ^{27}Al. Multipole mixing ratios are presented and compared with the predictions for mirror nuclei recently reported for sd-shell nuclei. (11 figures, 2 tables) (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 18477, 19237, 19257, 19262, 19270, 19302, 19306, 19307, 19336, and 19428.

19274 (JUL-788-NP) REACTION ^{39}K(n,γ)^{40}K. COINCIDENCE AND ANGULAR CORRELATION MEASUREMENT BY MEANS OF A TWO-DIMENSIONAL MEASURING APPARATUS. Goettel, Peter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik). Aug 1971. 98p. (In German). Dep. NTIS (U.S. Sales Only).

The excitation states in ^{40}K were populated with the ^{39}K(n,γ)^{40}K reaction. The transitions between the (n $p_{\frac{3}{2}}^{+1}$ p $d_{\frac{3}{2}}^{-1}$) and the (n $f_{\frac{7}{2}}^{+1}$ p $d_{\frac{3}{2}}^{-1}$) quadruplet must, when it is a pure configuration, obey the l selection rule, the mixing ratio for the 1303- and 1247-kev transitions have the values Q(1303) = 0.03 ± 0.02 and Q(1247) – 0.05 ± 0.3. This means that both transitions have a preponderantly M1 radiation character. The strong M1 components are explainable only by the assumption of such mixing in the initial and final states which permit a ($\Delta l = l$) transition. The mixing (n $f_{\frac{7}{2}}^{+1}$ p $d_{\frac{3}{2}}^{-1}$) in the states of the (n $p_{\frac{3}{2}}^{+1}$ p $d_{\frac{3}{2}}^{-1}$) quadruplet and of (n $p_{\frac{3}{2}}^{+1}$ p $d_{\frac{3}{2}}^{-1}$) in the states of the (n $f_{\frac{7}{2}}^{+1}$ p $d_{\frac{3}{2}}^{-1}$) quadruplet must be considered. Only development coefficients A_{kk} up to the degree k appear in the angular correlation function, which is determined by the condition k- Min($2L_1$,$2L_2$,2I). If there is a transition in a cascade of pure dipole character independent of the mixing of the unknown transitions, an A_4 coefficient does not appear. (J.S.R.)

19275 K-ELECTRON-CAPTURE RATE DETERMINATION OF ^{55}Fe BY LIQUID SCINTILLATION COUNTING. Yura, Osamu (Electrotechnical Lab., Tokyo). Radioisotopes (Tokyo); 20: No. 11, 610-11(Nov 1971).

The K-electron-capture rate of ^{55}Fe was determined by liquid scintillation counting using a ^{210}Po sample of known activity as an efficiency tracer. The pulse height spectra and an efficiency tracing curve are presented. (J.W.R.)

19276 ROLE OF γ-RAY EMISSION FROM NUCLEON UNBOUND STATES IN THE MECHANISM OF COMPOUND NUCLEAR REACTIONS. Sarantites, Demetrios G.; Hoffman, Edward J. (Washington Univ., St. Louis). Nucl. Phys.; A180: No. 1, 177-207(1972).

The compound statistical theory for nuclear reactions was employed to compute total cross sections for many levels in ^{61}Cu and ^{60}Ni populated via (^{4}He, pγ) and (^{4}He, 2pγ) reactions on ^{58}Ni. Angular momentum effects and photon emission from the continuum were included in the formalism. Decay to the well-known discrete states in ^{61}Cu and ^{60}Ni is treated separately and for higher excitations the level spectrum is represented by a level-density expression. The cross sections for many levels in ^{61}Cu and ^{60}Ni were calculated as a function of excitation energy in the ^{61}Cu compound nucleus from where the γ-cascades originate in competition with nucleon emission. Spectra of protons populating levels in ^{61}Cu and ^{60}Ni via (^{4}He, pγ) and (^{4}He, 2pγ) reactions were also calculated. Fermi-gas-model expressions for nuclear level densities were employed with nuclear moments of inertia approaching the rigid-rotor value with increasing excitation energy. The calculated level cross sections and particle spectra were compared with recent experimental results to determine the level-spacing parameter a as $^1/_{10}$A. By comparison with experimental independent yields ratios for many levels in ^{61}Cu the following quantities were deduced: (a) the moment of inertia as (0.7 – 0.8) I_{rig} for 8-12 MeV of excitation in ^{61}Cu and (b) the fraction of decay of the continuum states by quadrupole radiation. The γ-transition strength for E1 of M1 and E2 radiations were obtained from (^{4}He, pγ)/(^{4}He, 2pγ) cross-section ratios and were found to correspond to E1 or M1 retardation factors of ≈350 or ≈7, respectively, and to E2 enhancement factors of ≈35 over the single-proton estimates. At the higher bombardment energies it is found that the $^9/_2$ and $^{11}/_2$ states in ^{61}Cu are populated via cascades through the yrast line with ≈25% of the yield carried by dipole radiation. The states with $J \leq {}^1/_2$ are populated primarily by quadrupole transitions not involving the yrast line. The variation with bombardment energy of the independent yield ratios for the levels in ^{61}Cu and ^{60}Ni is well reproduced. The region in the EJ diagram for ^{61}Cu where γ-emission dominates is also deduced. (auth)

19277 DOPPLER-SHIFT LIFETIME MEASUREMENTS IN ^{46}Ti AND ^{50}Cr. Assimakopoulos, P. A.; Becker, T.; Moazed, Cyrus; Van Patter, D. M. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A180: No. 1, 131-56(1972).

The lifetimes of nine states in ^{46}Ti and fourteen states in ^{50}Cr have been measured through the Doppler-shift attenuation method. The states were populated by the ^{46}Ti(p,p'γ) and ^{50}Cr(p,p'γ) reactions at $E_p = 7$ MeV. Thick targets (≈300 keV) were used to provide adequate averaging over many compound-nucleus levels. Singles γ-ray spectra were obtained with 33 and 55 cm^3 Ge(Li) detectors at $\theta_\gamma = 0°$, 90° and ≈160°, and lifetimes were extracted from the observed centroid shifts. An alternative method of analysis, involving a simulation of profiles of Doppler-shifted peaks with six free parameters gave considerably more accurate results. Both methods were tested by measuring known lifetimes in ^{58}Ni. In addition, the lifetimes of three states in ^{52}Cr were determined. A comparison of the energy spectra and electromagnetic decay properties of these nuclei to shell-model calculations revealed the failure of the simple $(f_{\frac{7}{2}})^6$ picture. A startling example of this failure is the fact that the $2_1^+(E2)2_1^+$ rate in ^{46}Ti appears to be a factor of ≳25 faster than that in the cross-conjugate nucleus ^{50}Cr. (auth)

19278 $K^\pi = {}^1/_2{}^+$ ROTATIONAL BAND IN ^{43}Sc. Ball, G. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Forster, J. S.; Ward, D.; Monahan, C. F. Phys. Lett.; 37B: No. 4, 366-8(13 Dec 1971).

A coincidence recoil-distance Doppler-shift method has been used to obtain lifetimes (ps) for the following levels in ^{43}Sc: 472 keV, $^3/_2{}^-$, 220 ± 30; 855 keV, $^1/_2{}^+$, 32 ± 4; 880 keV, $^5/_2{}^+$, 6.0 ± 1.5; and 1159 keV, $^3/_2{}^+$, 6.4 ± 1.5. Absolute transition strengths are compared with the theoretical predictions of Johnstone. (auth)

19279 PERTURBATIVE TREATMENT OF COLLECTIVE PARTICLE–HOLE STATES IN ^{40}Ca AND ^{48}Ca. Dworzecka, M.;

McManus, H. (Michigan State Univ., East Lansing). Phys. Lett.; 37B: No. 4, 331-4(13 Dec 1971).

The effects of ground state correlations and core polarization have been included in the effective particle-hole interaction and transition moments by second order perturbation theory. Energy levels and transition probabilities of 3^- collective states in ^{40}Ca and ^{48}Ca were calculated in Tamm–Dancoff approximation and compared with the results obtained by using the random phase approximation. (auth)

19280 $19/2^-$ (3.12 MeV) STATE IN ^{43}Sc AND THE 6^+ (3.19 MeV) STATE IN ^{42}Ca. Johnstone, I. P.; Castel, B. (Queen's Univ., Kingston, Ont.). Phys. Lett.; 37B: No. 4, 329-30(13 Dec 1971).

Theoretical values for the magnetic moments of the ^{43}Sc $19/2^-$ state and ^{42}Ca 6^+ state agree with experiment, but two-hole admixtures can not account for a discrepancy between theoretical and experimental ^{42}Sc(7^+) → ^{42}Ca(6^+) β decay ft values. (auth)

19281 ^{212}Pb (ThB) AS A TIME CALIBRATION STANDARD FOR DELAYED COINCIDENCE MEASUREMENTS. Vaelivaara, K. G.; Marelius, A. (Uppsala Univ.). Phys. Scr.; 3: No. 3-4, 111-12(1971).

Half lives of some excited states in decay products of ThB(^{212}Pb) have been measured by the delayed coincidence technique. For ^{208}Pb the results are: 3,198 keV level 286 ± 26 ps, 3,475 keV level 4 ± 3 ps, 3,961 keV level ≤ 18 ps. For ^{212}Bi the results are: 238 keV level ≤ 5 ps, 415 keV level ≤ 10 ps, 115 keV level (8 ± 4) ps. The use of ThB, ^{60}Co and ^{198}Au as time calibration standards is discussed. (auth)

19282 HIGHLY NEUTRON-DEFICIENT VANADIUM ISOTOPE: ^{44}V. Cerny, J. (Brookhaven National Lab., Upton, N. Y. Univ. of California, Berkeley); Goosman, D. R.; Alburger, D. E. Phys. Lett.; 37B: No. 4, 380-2(13 Dec 1971).

Vanadium-44, with a half-life of 90 ± 25 ms, has been produced by the ^{40}Ca(^{6}Li,2n)^{44}V reaction induced by 18.5 MeV lithium ions; β-delayed α-particles of 3.05 ± 0.20 MeV (c.m.) were observed with a production cross section of ≈100 nb. (auth)

19283 INVESTIGATION OF NUCLEI ^{28}Si, ^{47,49}V IN (d,n) REACTIONS. Okorokov, V. V.; Serezhin, V. M.; Smotryaev, V. A.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 3, 490-8(Sep 1971). (In Russian).

Proton states of ^{28}Si and ^{47,49}V were investigated in (d,n) reactions. The neutron energies were determined by means of the time-of-flight method. The experimental results are compared with calculations using the distorted-wave method. (2 figures, 4 tables) (auth)

19284 LIFETIME MEASUREMENTS ^{52}Cr BY THE DOPPLER SHIFT ATTENUATION METHOD. Sprague, Stanley Wayne. Columbus, Ohio; Ohio State Univ. (1971). 159p. University Microfilms Order No. 71-27,567.

Thesis.

Mean lifetimes of the excited states of ^{52}Cr have been measured for several levels up to 4.5 MeV in excitation by means of the Doppler Shift Attenuation Method (DSAM). The excited states of ^{52}Cr were populated by the ^{51}V(^{3}He,d)^{52}Cr reaction with ^{3}He^{++} beams of 9.0 and 11.0 MeV. Spectra were recorded at 30°, 90° and 150° with respect to the beam direction with a 38.5 cm^3 Ge(Li) detector. From these spectra the gamma energy shifts were determined and the experimental attenuation factor F was obtained. The calculated expression for the attenuation factor $F(\tau)$ was obtained by using the formalism of Blaugrund. Comparisons of the single particle enhancements obtained from the measured lifetimes with a compilation of other measured single particle enhancements for $1f_{\frac{7}{2}}$ nuclei enables one in many cases to make arguments about other nuclear properties, e.g., spin, parity, mixing ratios, etc. Such comparisons combined with the angular correlation results of Monahan et al. indicate spin–parity assignments of 4^+ for the level at 3414 keV and 5^+ for the level at 4015 keV. The lifetime results are also in good agreement with the assignment of 4^+ to the level at 4040 keV and 3^- to the level at 4563 keV made by Peterson. All the levels except the ones at 3772 and 3472 keV can be at least tentatively described in terms of simple shell model configurations. The experiment lifetimes are compared to the predictions of various shell model calculations. (Diss. Abstr. Int., B)

19285 STUDY OF EXCITED STATES IN ^{56}Cu, ^{54}Co, ^{50}Mn, AND ^{46}V. King, N. S. P.; Moss, C. E.; Baer, H. W.; Ristinen, R. A. (Univ. of Colorado, Boulder). Nucl. Phys.; A177: No. 2, 625-49(1971).

Levels of the doubly odd N = Z nuclei ^{54}Co, ^{58}Cu, ^{50}Mn, and ^{46}V were studied with the (p,nγ) reaction at E_p = 7 to 16 MeV. The neutrons were detected in an NE-224 scintillator, and the γ rays in coincidence were detected in a Ge(Li) detector. Additional information on the level structure and relative excited state populations was obtained from neutron time-of-flight spectra from the (p,n) reactions and from a triton spectrum from the ^{46}Ti(^{3}He,t)^{46}V reaction. Level schemes and restrictions on possible spins based on the γ-ray data are given for each nucleus up to an excitation energy of approximately 2 MeV. (14 figures, 9 tables) (auth)

19286 INELASTIC SCATTERING OF 50 MeV PROTONS TO THE DEFORMED STATES IN ^{42}Ca. Mani, G. S.; Jacques, D. (Manchester Univ., Eng.). Nucl. Phys.; A177: No. 2, 448-64(1971).

The inelastic scattering of 49.75-MeV protons by ^{42}Ca was studied. Angular distributions for thirteen excited states up to an excitation energy of 5 MeV in ^{42}Ca were obtained. Spin and parity assignments were made on the basis of a DWBA analysis with first-order collective form factors. The deformation parameters obtained from such an analysis were compared with other results. A microscopic-model calculation with 4p–2h deformed components in the nuclear wave functions was carried out, and the results are discussed in terms of the structure of ^{42}Ca. (8 figures, 4 tables) (auth)

19287 CIRCULAR POLARIZATION OF NEUTRON CAPTURE γ-RAYS FROM Mn, Ni, Ga, AND W. Stecher-Rasmussen, F.; Kopecky, J.; Abrahams, K.; Ratynski, W. (Reactor Centrum Nederland, Petten). Nucl. Phys.; A181: No. 1, 250-61(1972).

Capture γ-ray circular polarization measurements on the Mn(n,γ), Ni(n,γ), Ga(n,γ) and W(n,γ) reactions with polarized neutrons resulted in unambiguous spin assignments for 20 levels, 10 of which confirmed previous assignments. For another 20 levels the number of possible spin values has been reduced. (auth)

19288 ENERGY LEVELS OF ^{56}Ni AND ^{60}Zn FROM (^{3}He,n) REACTIONS. Winsborrow, R. P. J.; Macefield, B. E. F. (Oxford Univ.). Nucl. Phys.; A182: No. 3, 481-96(1972).

A thick radiator recoil telescope was used to measure angular distributions for the reactions ^{54}Fe(^{3}He,n)^{56}Ni and ^{58}Ni(^{3}He,n)^{60}Zn at energies of 14 and 15 MeV respectively. Good agreement is obtained with angular distributions predicted by DWBA double-stripping calculations. These comparisons indicate the following assignments: ^{56}Ni ground state 0^+, 2.5 ± 0.1 MeV 2^+, 3.95 ± 0.1 MeV 0^+, 6.5 ± 0.15 MeV 0^+, 7.95 ± 0.2 MeV 0^+ T = 1, 8.65 ± 0.15 MeV (1^-, 0^+ + 2^+) and 10.1 ± 0.2 MeV 0^+ T = 2; ^{60}Zn ground state 0^+, 1.01 ± 0.2 MeV 2^+, 6.88 ± 0.2 MeV 0^+ and 7.47 ± 0.2 MeV 0^+ T = 2. The relative intensity of excitation of levels is compared with pairing vibrational model predictions. (auth)

19289 GAMMA RAYS FROM THERMAL-NEUTRON CAPTURE IN NATURAL AND ^{39}K ENRICHED POTASSIUM. Op Den Kamp, A. M. F.; Spits, A. M. J. (Rijksuniversiteit, Utrecht). Nucl. Phys.; A180: No. 2, 569-86(1972).

Gamma rays following thermal-neutron capture in natural and in ^{39}K enriched potassium have been investigated with a Ge(Li)–NaI spectrometer. In the ^{39}K(n,γ)^{40}K reaction 222 γ-rays were found, of which 187 could be fitted into the level scheme of ^{40}K. Fifteen γ-rays could be ascribed to the ^{41}K(n,γ)^{42}K reaction. Excitation energies of 54 levels in ^{40}K and of 9 levels in ^{42}K have been determined with 0.2 to 1.0 keV errors. The Q-values of the ^{39}K(n,γ)^{40}K and ^{41}K(n,γ)^{42}K reactions are Q = 7799.7 ± 0.8 keV and 7533.9 ± 1.2 keV, respectively. (auth)

19290 PROTON SPIN-FLIP IN THE MICROSCOPIC DISTORTED-WAVE APPROXIMATION. McDaniel, F. D. (Univ. of Georgia, Athens); Amos, K. A. Nucl. Phys.; A180: No. 2, 497-516(1972).

The differential cross section, spin-flip probability amplitude and asymmetry for the inelastic scattering of 19.6 MeV protons to the first 2^+ state in ^{54}Fe are analyzed using an antisymmetrized distorted-wave approximation. Core-polarization effects dominate all the analyses. These yield results similar to the collective-model analyses. The contributions of the microscopic components are small but show significant effects. The exchange terms give spin-flip probabilities that peak in regions where the data has a peak and the collective-model analyses do not. The necessity of including exchange amplitudes either in a much extended shell-model description of the target states or through the exchange core-polarization matrix elements is suggested. (auth)

19291 INVESTIGATION OF SHORT-LIVED ACTIVITIES IN ^{18}F, ^{22}Na, ^{40}K, ^{85}Rb, AND ^{92}Mo EXCITED BY 14.7 MeV FAST NEUTRONS. Adam, A.; Horvath, D.; Kiss, A.; Mayr, E. Nucl. Phys.; A180: No. 2, 587-92(1972).

The production of short-lived isomeric states in ^{18}F, ^{22}Na, ^{40}K, ^{85}Rb and ^{92}Mo was investigated by 14.7 MeV fast neutrons. A

combined α-particle and pulsed-beam method was used to measure the time distribution of γ-rays produced in the deexcitation process. The spin cut-off factors were obtained from the experimental cross sections and other known values by means of the Huizenga–Vandenbosch method. Half-lives of the isomeric levels of the nuclei were also deduced. (auth)

19292 K-X-RAY-γ DIRECTIONAL CORRELATIONS IN THE DECAY OF ^{54}Mn, ^{65}Zn, ^{75}Se, ^{85}Sr, ^{133}Ba, AND ^{207}Bi. Bosch, H. E.; Fariolli, M. A.; Behar, M.; Garcia Bermudez, G. (Univ. of Buenos Aires). Nuovo Cim.; 6A: No. 4, 576-80(21 Dec 1971).

K-X-ray-γ directional correlations following the decay of ^{54}Mn, ^{65}Zn, ^{75}Se, ^{85}Sr, ^{133}Ba and ^{207}Bi have been performed. The experimental set-up consisted of a set of four scintillation counters, one for detecting X-rays and the three others for detecting γ-rays, placed at 90°, 180° and 270° with respect to the source to X-ray detector direction. Multiple coincidence units and a logic system were used in order to display three X-ray spectra in three 128-channel submemories of a 512-channel analyzer, corresponding to coincidences between X-rays and γ-rays detected in each counter, respectively. For the case of the ^{133}Ba X-γ angular correlation, the scintillation counters were replaced by one Ge(Li) detector in order to select with high resolution the γ-ray of 356 keV. Corrections for chance coincidences were made and a χ^2-test of the data was performed. From the K-X-γ directional correlations following the above-mentioned decays a value of the anisotropy was derived. In all cases this value is consistent with zero to within a one percent error. These results are in agreement with the theoretical predictions of Dolginov. A discrepancy with the anisotropy value reported by Perepelkin appeared. The values corresponding to the decays of ^{65}Zn, ^{85}Sr and ^{133}Ba are consistent with the ones reported by Ramaswamy and McDonnell and Ramaswamy. (auth)

19293 ^{56}Fe(p,nγ)^{56}Co COINCIDENCE EXPERIMENTS AT SEVERAL BEAM ENERGIES. DelVecchio, R.; Gibson, R. F.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., C; 5: No. 2, 446-52(Feb 1972).

Levels of ^{56}Co up to 2.6 MeV of excitation were studied by ^{56}Fe(p,nγ) coincidence experiments. γ rays were detected with a 40-cm^3 coaxial Ge(Li) detector. Neutrons were detected with a 1000-cm^3 liquid scintillation counter. Pulse-shape discrimination was used to distinguish neutrons from the γ-ray contamination in the neutron detector. Energy and time-of-flight information was stored for each coincident event on magnetic tape with 1024 × 256-channel resolution. Gated one-dimensional γ spectra were also taken with 4096-channel resolution in order to obtain accurate energies (±0.5 keV). Proton beam energies of 7.7, 8.1, 8.5, 9.5, and 10 MeV were used to determine the approximate threshold for the appearance of the individual γ rays. Twenty-one ^{56}Co γ rays were identified. The decay scheme constructed is consistent with the known information on this nucleus. The experimental procedure is discussed in some detail. (8 figures, 1 table) (auth)

19294 LEVEL STRUCTURE OF ^{44}Ti. Rapaport, J. (Ohio Univ., Athens); Ball, J. B.; Auble, R. L.; Belote, T. A.; Dorenbusch, W. E. Phys. Rev., C; 5: No. 2, 453-63(Feb 1972).

The level structure of ^{44}Ti was studied using the ^{46}Ti(p,t) reaction at a proton energy of 51 MeV. Experimental angular distributions were compared with distorted-wave Born-approximation calculations to determine the angular momentum transfers. Spins, parities, and enhancement factors were extracted for the levels observed up to 9.330 MeV excitation energy. The measured Q value for the ground-state transition was determined to be −14.235 ± 0.010 MeV. A strong L = 2 transition at E_x = 6.600 MeV is assigned as the T = 1 analog of the ^{44}Sc ground state, and an L = 0 transition at 9.330 MeV is assigned as the T = 2 analog of the ^{44}Ca ground state. (9 figures, 3 tables) (auth)

19295 GAMMA-RAY SPECTRA AND LEVEL STRUCTURE OF ^{44}Ca FROM THERMAL-NEUTRON CAPTURE IN ^{43}Ca. White, D. H.; Birkett, R. E. (Univ. of California, Livermore). Phys. Rev., C; 5: No. 2, 513-27(Feb 1972).

Gamma-ray measurements were made of the ^{43}Ca(n,γ)^{44}Ca reaction at the Livermore pool-type reactor. Singles spectra were taken with Ge(Li)–NaI(Tl) Compton-suppression and pair-coincidence spectrometers. A total of 280 observed γ rays were attributed to capture by ^{43}Ca. Ge(Li)–Ge(Li) coincidence measurements using a three-parameter analyzer system (E_1,E_2,ΔT) were analyzed, and 129 of the observed transitions were assigned to 45 inferred levels in ^{44}Ca. Comparison of l = 1 (d,p) strengths (2J + 1)S_n with (n,γ) strengths I/E^3 leading to the same final states yields a positive correlation coefficient of 0.63. The neutron binding energy is determined to be 11131.6 ± 0.7 keV. (8 figures, 5 tables) (auth)

19296 g FACTOR OF THE $^{19}/_2^-$ ISOMERIC STATE IN ^{43}Sc. Hsieh, S. T.; Lee, T. Y.; Yang, C. M. (National Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., C; 5: No. 2, 593-5(Feb 1972).

The g factor of the $^{19}/_2^-$ state in ^{43}Sc is discussed within the framework of the conventional shell model. An inert ^{40}Ca core is assumed. The effective interaction derived for this mass region by Kuo and Brown is used. It is shown that the g factor can be well explained with a small configuration mixing. The g factor of the 6^+ state in ^{42}Ca is also discussed. (2 figures, 1 table) (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 19287, 19288, 19291, 19292, 19323, 19336, 19411, 19414, and 19428.

19297 ANALYSIS OF THRICE-FORBIDDEN β TRANSITIONS IN ^{87}Rb. Kopytin, I. V.; Suslov, Yu. P. (Voronezh State Univ., USSR). Yadern. Fiz.; 14: No. 3, 615-23(Sep 1971). (In Russian).

Direct calculations of the half-life and the spectrum form for the thrice-forbidden transition $^3/_2^- \rightarrow {}^9/_2^+$ are used to test the predictions of the conserved vector current theory. It is shown that the experiment may be explained only on basis of the Domgard–Winter estimate and not with that by Fujita. Both the account of the polarization of the nuclear core and the use of the exact electron wave functions are found to be equally essential. The latter is due to the fact that in the case considered there is the so-called accidental cancellation of the nuclear matrix elements. Renormalization of the pseudovector coupling, g_A, by the nuclear forces is estimated. It is shown that the value of the renormalized pseudovector coupling constant compatible with the spectrum of ^{87}Rb is no less than 0.9 g_A. (1 figure, 2 tables) (auth)

19298 CORIOLIS COUPLING MODEL APPLIED TO ODD NEUTRON NUCLEI OF THE $1g_{9/2}$ SHELL. Heller, Sherman Louis. Brooklyn; Polytechnic Inst. of Brooklyn (1971). 125p. University Microfilms Order No. 71-29,059.

Thesis.

A Coriolis-coupling model extended to include a residual pairing-type interaction is applied to investigate the properties of low-lying states of the odd nuclei of the $1g_{9/2}$ shell (73 < A < 87). This deformed rotational treatment includes spectra of both parities originating from overlapping states of the N = 4 and N = 3 positive- and negative-parity shells. Single-particle energy levels and wave functions throughout a shell are computed using spin–orbit and well-flattening parameters $C = -0.26\hbar\omega_0$ and $D_{N=4,3} = -0.04\hbar\omega_0$, $-0.053\hbar\omega_0$, respectively, the latter values being consistent with $d_{5/2}$ parentage states of ^{79}Se (positive parity) and $f_{5/2}$ states of ^{83}Kr (negative parity). Inclusion of an extra-core pairing interaction primarily introduces a multiplicative effective overlap which serves as a quenching factor to the strength of off-diagonal Coriolis-coupling terms. All parameters in the analysis are taken from available experimental considerations. For each set of parameters both a single-particle and a Coriolis-coupling diagonalization are performed over an entire shell of 10 or 15 Nilsson states to obtain final negative- or positive-parity spectra and wave functions. The wave functions generated by the model are used to calculate various electromagnetic properties of several low-lying levels of the nuclei investigated. The results of this essentially fixed-parameter model are presented and compared with experimental determinations with which they are in substantial agreement. In general, the model favors a prolate description for the nuclei in this region. The systematic reproduction of experimental observations provided by the model points to the validity of a statistically deformed interpretation of the odd-neutron nuclei of the $1g_{9/2}$ shell, in contrast to the purely spherical and vibrational approaches to which the region has been restricted in the past. (Diss. Abstr. Int., B)

19299 ENERGY LEVELS IN ^{76}Ge FROM THE DECAY OF ^{76}Ga. Camp, David C. (Univ. of California, Livermore); Foster, Bruce P. Nucl. Phys.; A177: No. 2, 401-17(1971).

The γ-ray decay scheme and nuclear energy levels in ^{76}Ge were investigated from the decay of ^{76}Ga by using a high-resolution 38-cm^3 Ge(Li) detector. The half-life of ^{76}Ga was determined to be 27.1 ± 0.2 s. Energies and intensities are given for 107 γ-ray transitions, of which 97 are placed in a proposed level scheme containing 25 definitive and 16 tentative levels. Log-ft values are deduced from the relative γ-ray intensities. Spin and parity assignments are proposed for some of the levels. (4 figures, 2 tables) (auth)

19300 HALF-LIFE OF THE $9/2^+$ STATE IN ^{67}Zn. Sawa, Z. P.; Sztarkier, J. (Forskningsinstitutet foer Atomfysik, Stockholm). Phys. Scr.; 3: No. 6, 243-4(1971).

Using the externally pulsed 30-MeV α beam of the 225-cm cyclotron, the half-life of 605-keV state in ^{67}Zn was measured. The obtained $T_{\frac{1}{2}}$ = (300 ± 30) ns yields a hindrance factor 13 for the corresponding M2 γ-ray transition. (auth) (Sweden)

19301 EFFECTIVE INTERACTION AMONG $1g_{\frac{9}{2}}$ AND $2p_{\frac{1}{2}}$ NEUTRONS IN THE STRONTIUM ISOTOPES. Kitching, J. E. (Nuclear Physics Lab., Oxford. McGill Univ., Montreal); Davies, W. G.; Darcey, W. J.; McLatchie, W.; Morton, J. Nucl. Phys.; A177: No. 2, 433-47(1971).

In the seniority scheme an effective-interaction shell-model calculation was carried out for the low-lying structure of the strontium isotopes. The model predictions are compared with existing experimental data, and the quality of the seniority quantum number is evaluated. Differences between effective neutron matrix elements are determined and compared with the corresponding proton case. Comparisons of predicted two-neutron-transfer cross sections with experimental data are used to remove ambiguities in the sign of certain off-diagonal matrix elements. (auth)

19302 NON-LOCAL OPTICAL POTENTIAL FOR COMPOSITE PARTICLES. Samaddar, S. K.; Mukherjee, Suprokash (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys.; A177: No. 2, 598-624(1971).

Angular distributions for the elastic scattering of protons are analyzed using a nonlocal potential in the form used by Perey and Buck for neutrons. By means of this optical potential for the proton and the Perey–Buck potential for the neutron, optical potentials for the elastic scattering of deuterons and ^{3}He particles are calculated. These potentials are used to calculate elastic scattering angular distributions of these particles from various targets, and the calculations are compared with experimental results. Limitations in generating the optical potential for a composite particle in terms of a local and energy-dependent potential for the nucleons are discussed. Some qualitative estimates for the nonlocality and the intrinsic energy dependence of the nucleon optical potential are also obtained. (13 figures, 8 tables) (auth)

19303 γ-RAY SPECTRUM OF SHORT-LIVED FISSION-PRODUCT BROMINE ISOTOPES AND THE DECAY SCHEME OF 3.0-MIN ^{85}Br. Erten, H. N.; Coryell, C. D. (Massachusetts Inst. of Tech., Cambridge). J. Inorg. Nucl. Chem.; 33: No. 11, 3621-6(Nov 1971).

By observing the γ-ray spectra of short-lived bromine species separated from fission products at different times after irradiation, it was possible to differentiate between some of the γ-rays belonging to the decay of 54 sec ^{86}Br and 55 sec ^{87}Br. Three γ-rays of 801.6, 832.0, and 925.1 keV were found to decay with a 3.0 min half-life and they are assigned to the decay of 3.0 min ^{85}Br. Together with the results of nuclear excitation studies in ^{85}Kr, a decay scheme is constructed for ^{85}Br, with levels in ^{85}Kr at 305, 1106.6, 1137.0, and 1230.1 keV. (auth)

19304 NUCLEAR LIFETIME MEASUREMENTS OF SOME EXCITED STATES IN ^{75}As, ^{131}Cs, ^{133}Cs, ^{170}Yb, ^{187}Re, AND ^{197}Au. Gupta, D. K.; Rao, G. N. (Indian Inst. of Tech., Kanpur). Nucl. Phys.; A182: No. 3, 669-72(1972).

The half-lives of some short-lived nuclear excited states in ^{75}As, ^{131}Cs, ^{133}Cs, ^{170}Yb, ^{187}Re and ^{197}Au are measured using the delayed-coincidence technique. A new value of $T_{\frac{1}{2}}$ = 8.1 ± 0.1 nsec is reported for the 134 keV level in ^{131}Cs. The present values are compared with the previous measurements. (auth)

19305 STUDY OF THE ^{59}Co(n,gamma)^{60}Co REACTION WITH POLARIZED THERMAL NEUTRONS. Stecher-Rasmussen, F.; Abrahams, K.; Kopecky, J. (Reactor Centrum Nederland, Petten). Nucl. Phys.; A181: No. 1, 241-9(1972).

The circular polarization of 15 primary γ rays from the capture of polarized thermal neutrons in ^{59}Co has been measured. Six spins have been assigned. The results are discussed in terms of single-particle states with superimposed proton core excitations. A possible connection between the neutron capture mechanism and the primary capture γ-ray spectrum is pointed out. (auth)

19306 REACTIONS INDUCED BY ^{3}He IONS ON ^{64}Zn. Crisler, D. F. (Univ. of Wyoming, Laramie); Eldridge, H. B.; Kunselman, R.; Zaidins, C. S. Phys. Rev., C; 5: No. 2, 419-30(Feb 1972).

Foils of enriched ^{64}Zn (99.85%) were bombarded by ^{3}He particles with energies of 22.2, 29.5, 37.7, and 43.4 MeV, after which γ-ray spectra were accumulated from the radioactive foils with a large Ge(Li) detector and a 4096-channel pulse-height analyzer system. The isotopes produced were determined by the β-delayed γ rays and their corresponding half-lives. No chemical separation of the foils was performed. Cross sections for a particular reaction were determined for each isotope and beam energy. The resulting excitation functions for the 13 reactions which were detected are presented and compared with similar reactions including those induced by ^{3}He on Cu isotopes. Possible reaction mechanisms are discussed. The principal reaction mechanism appears to be that of direct reactions especially at higher ^{3}He-particle energies where cluster-transfer reactions are common. (6 figures, 4 tables) (auth)

19307 LEVELS OF ^{59}Co POPULATED IN COMPOUND-NUCLEAR REACTIONS. Kennedy, A. J.; Pacer, J. C.; Sprinzak, A.; Wiley, J.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 5: No. 2, 500-12(Feb 1972).

Highly excited levels of ^{59}Co were populated by the ^{59}Co(p,p') and ^{62}Ni(p,α) reactions induced by 14.0-MeV protons and by the ^{56}Fe(α,p) and ^{59}Co(α,α') reactions induced by 16.5-MeV α particles. Energy spectra were measured over the 30 to 150° angular interval; and the results, compared with the spin- and isospin-dependent statistical theory. The (p,α), (α,α'), and (α,p) reaction spectra could all be fitted with the same level-density parameter and pairing energy of ^{59}Co: $a = 7.5$ MeV^{-1} and $\delta = 1.29$ MeV. In order to obtain agreement with these same parameters for the (p,p') reaction spectrum it was necessary to invoke a 30 to 40% contribution from a pre-equilibrium emission process. The sensitivity of the results of the various parameters of the theory is explored. (11 figures, 3 tables) (auth)

19308 ISOSPIN AND THE BOHR INDEPENDENCE HYPOTHESIS. Vaz, Louis C.; Lu, C. C.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Phys. Rev., C; 5: No. 2, 463-76(Feb 1972).

The influence of isospin on statistical nuclear decay at approximately 20 MeV is investigated for two composite systems, ^{66}Zn and ^{64}Zn, by measurement of the cross sections and the energy spectra of protons and α particles emitted from the two composite systems. The composite system ^{66}Zn was formed at an excitation energy of 19.7 MeV in the ^{65}Cu + p and ^{62}Ni + α reactions, while the composite system ^{64}Zn was formed at an excitation energy of 19.5 MeV in the ^{63}Cu + p and ^{60}Ni + α reactions. In both systems the experimental cross-section ratio $\sigma(\alpha,\alpha')\sigma(p,p')/\sigma(\alpha,p)\sigma(p,\alpha)$ exceeded the value of approximately unity predicted by the Bohr independence hypothesis and the statistical theory of compound-nuclear decay including angular momentum. The cross-section ratios were 2.2 ± 0.2 and 1.3 ± 0.1 for the ^{66}Zn and ^{64}Zn composite systems, respectively. The major part of the deviation of these ratios from unity in both the composite systems is ascribed to an isospin selection rule acting in the $T_<$ states of both composite systems which causes these states to decay preferentially by proton emission. Other factors which might enhance these ratios, such as direct reactions and reduced moments of inertia, are considered and are found to change the above ratios by a relatively small amount. (10 figures, 2 tables) (auth)

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Refer also to abstracts 18180, 19292, 19304, 19411, 19415, and 19428.

19309 (COO–1779-64) COLLECTIVE EFFECTS SHOWN BY THE (p,t) REACTION ON THE CLOSED-SHELL NUCLEUS, ^{141}Pr. Goles, R. W.; Warner, R. A.; McHarris, Wm. C.; Kelly, W. H. (Michigan State Univ., East Lansing. Cyclotron Lab.). [1971]. 10p. (MSUCL–46). Dep. NTIS.

The ^{141}Pr(p,t)^{139}Pr reaction at 40 MeV strongly populates collective states in the residual nucleus. The shapes of the angular distributions, taken at 5° intervals between 15° and 65°, show the inadequacies even of finite-range, two-nucleon pick-up DWBA calculations and the need for inclusion of second-order effects. (auth)

19310 ONE- AND THREE-QUASIPARTICLE STATES IN ^{121}Sn. Casten, R. F.; Flynn, E. R.; Hansen, Ole; Mulligan, T. J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A180: No. 1, 49-68(1972).

The reactions ^{119}Sn(t,p)^{121}Sn and ^{120}Sn(t,d)^{121}Sn have been studied at 13 MeV bombarding energy with energy resolutions of 15 keV and 11 keV, respectively. Angular distributions were measured from 12 to 66° in 6° steps and values of the transferred orbital angular momentum were derived. In the (t,d) case, spectroscopic factors are presented. Considerable f-strength from the (t,d) reaction is found near 2.5 MeV, which is about 2 MeV lower than expected from the single-particle model. One- and three-quasi-

particle components of the ^{121}Sn states are examined in some detail. It is concluded that in spite of considerable mixing, the low-lying levels seem amenable to a core-particle description. (auth)

19311 NUCLEAR LEVEL STUDIES OF ^{99}Ru. Gupta, D. K.; Rangacharyulu, C.; Singh, R.; Rao, G. N. (Indian Inst. of Tech., Kanpur). Nucl. Phys.; A180: No. 1, 311-20(1972).

The radioactive decay of 16.1 d ^{99}Rh has been studied using a Ge(Li)–Ge(Li) coincidence spectrometer and a NaI(Tl)–NaI(Tl) sum-coincidence spectrometer. Evidence for the existence of a new γ-ray of energy 910.8 keV is obtained. A level scheme for ^{99}Ru is established. Four new cascade transitions from the energy levels at 850.3, 1000.2, 1295.2 and 1382.9 keV are reported. The relative intensities and energies of all the γ-transitions are determined. The half-life of the 89.4 keV level is measured using the delayed coincidence method. The value obtained is 20.5 ± 0.1 nsec. (auth)

19312 EVIDENCE FOR A $J^\pi = 0^+$ FIRST EXCITED STATE OF ^{98}Zr THROUGH A MEASUREMENT OF INTERNAL CONVERSION ELECTRONS FROM FISSION PRODUCTS. Fogelberg, B. (Swedish Research Councils Lab., Studsvik, Sweden). Phys. Lett.; 37B: No. 4, 372-4(13 Dec 1971).

An investigation of conversion electrons from fission fragments and fission products of the ^{235}U(n,f) reaction has revealed a strong E0 transition in some isotope at Z = 40. Strong evidence that this transition depopulates the first excited state of ^{98}Zr is presented. (auth)

19313 COUPLED PARTICLE-PAIRING VIBRATIONAL EXCITATIONS IN ^{141}Nd AND ^{143}Nd BY THE (p,t) REACTION. Yagi, K.; Sato, K.; Aoki, Y. (Osaka Univ.). Phys. Lett.; 37B: No. 4, 369-71 (13 Dec 1971).

Coupled particle-monopole pairing vibrational states in ^{141}Nd and ^{143}Nd have been excited via (p,t) reactions on ^{143}Nd and ^{145}Nd. The 1.42 MeV state in ^{141}Nd, and the ground state and 3.04 MeV state in ^{143}Nd are assigned, respectively, as $(1,0)\ f_{\frac{7}{2}}$, $(0,0)\ f_{\frac{7}{2}}$ and $(1,1)\ f_{\frac{7}{2}}$. (auth)

19314 ELASTIC ELECTRON–ZIRCONIUM SCATTERING. Fajardo, L. A. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Ficenec, J. R.; Trower, W. P.; Sick, I. Phys. Lett.; 37B: No. 4, 363-5(13 Dec 1971).

Electron-zirconium elastic differential cross sections were measured at 300 MeV for the five stable isotopes. The isotopic dependence of several simple charge distributions was found from a phase shift analysis. (auth)

19315 E2/M1 MIXING RATIOS OF THE $2_2^+ \rightarrow 2_1^+$ GAMMA TRANSITIONS IN ^{132}Xe AND ^{132}Ba. Taylor, H. W.; Singh, B. (Univ. of Toronto). Can. J. Phys.; 49: No. 21, 2724-7(1 Nov 1971).

The E2/M1 mixing ratios for the $2_2^+ \rightarrow 2_1^+$ transitions of the 629.8–667.5 keV cascade in ^{132}Xe and the 567.0–464.5 keV cascade in ^{132}Ba were determined with a Ge(Li)–NaI(Tl) directional correlation spectrometer. The δ values are δ(629.8 keV, ^{132}Xe) = 18 and δ(567.0 keV, ^{132}Ba) = 9. The corresponding E2% admixtures are 99.7 for the 629.8 keV transition and 98.8 for the 567.0 keV transition. (auth) (Canada)

19316 INVESTIGATION OF THE CHARGE DENSITY DISTRIBUTION PARAMETERS IN THE $^{116\ 118\ 124}$Sn ISOTOPES BY ELECTRON ELASTIC SCATTERING. Litvinenko, A. S.; Shevchenko, N. G.; Buki, A. Yu.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 3, 479-83(Sep 1971). (In Russian).

The elastic scattering of electrons with an initial energy of 225.0 ± 0.2 MeV by ^{116,118,124}Sn nuclei was measured to study the dependence of the charge density distributions on the number of neutrons in nucleus. The results obtained are compared with the data of other experiments on electron scattering and muon capture. (2 figures, 4 tables) (auth)

19317 γ-DECAY OF ^{148}Sm NUCLEI AFTER THERMAL NEUTRON CAPTURE. Groshev, L. V.; Demidov, A. M.; Leonov, V. F.; Sokolovskii, L. L. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 3, 473-8(Sep 1971). (In Russian).

The γ-ray spectrum from thermal-neutron radiative capture by ^{147}Sm nuclei was measured by a one-crystal Ge(Li) spectrometer. Depletion of the sample in ^{149}Sm was obtained by the burning-out method in an integrated neutron flux of 2.2×10^{20} neutron/cm^2. The neutron binding energy in ^{148}Sm was found to be 8149.9 keV. The energies and the intensities were determined for γ lines separated from the spectrum. The ^{148}Sm decay scheme is constructed. The structure of excited states of the even–even Sm nuclei in the region 82 < N < 92 is discussed. (3 figures, 2 tables) (auth)

19318 ENERGY SPLITTING BETWEEN $T_>$ AND $T_<$ SINGLE PARTICLE STATES IN ^{91}Nb. Knoepfle, K. T. (Max-Planck Institut fuer Kernphysik, Heidelberg); Mayer-Boericke, C. Z. Phys.; 248: No. 4, 285-91(1971).

The isobaric energy splitting ΔE(n,l,j) between $T_>$- and $T_<$-single particle states in the shell ($2d_{\frac{5}{2}}$, $2d_{\frac{3}{2}}$, $1g_{\frac{9}{2}}$, $3s_{\frac{1}{2}}$) has been experimentally determined for ^{91}Nb from a study of the reaction ^{90}Zr(^{3}He,d)^{91}Nb. The splitting of the $1g_{\frac{9}{2}}$-states is found to be about 25% larger than that of the $3s_{\frac{1}{2}}$-states. The observed dependence of the energy splitting ΔE(n,l,j) on the shell model quantum numbers (n,l,j) of the states is reproduced by the expression $\Delta E(n,l,j) = \frac{1}{2}(2T+1)\langle\phi_>^{nlj}|\,U_1(r)\,|\phi_>^{nlj}\rangle$, which is based on approximate solutions of Lane's equations, $\phi_>^{nlj}$ is the wave function of the parent state in the (nC) system. There is evidence that only a Lane potential $U_1(r)$ of surface type can reproduce the observed strong dependence of ΔE(n,l,j) on the quantum numbers. The depth $\bar{U}_1$ of Lane's potential is found to be 2.0 MeV. (auth)

19319 INFLUENCE OF THE CHEMICAL ENVIRONMENT ON THE DECAY CONSTANT OF ^{90m}Nb. Smend, F.; Borchert, I.; Langhoff, H. (Univ., Gettingen, Ger.). Z. Phys.; 248: No. 4, 326-32(1971).

An influence of the chemical environment on the decay constant λ of the 2.38 keV isomeric transition of ^{90m}Nb was investigated. The relative difference of the decay constants for Nb atoms in Zr metal and in a fluorine complex was determined to be $|\lambda_{complex} - \lambda_{Zr}|/\lambda_{Zr} < 1.8 \cdot 10^{-3}$. This result is discussed in view of other experimental results and on theoretical estimates. (auth)

19320 DETERMINATION BY AN INDEPENDENT METHOD OF P_K ELECTRON CAPTURE PROBABILITIES IN ^{133}Ba AND ^{139}Ce DECAYS. GAMMA DECAY OF ^{133}Ba. Schmidt-Ott, W.-D.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Z. Phys.; 249: No. 4, 286-93(1972).

The electron-capture decays of ^{133}Ba (10.4 y) and ^{139}Ce (140 d) were investigated with high-resolution Ge(Li) detectors. By x-ray–γ-ray coincidences values of the quantity $P_K\omega_K\epsilon_K$ for various transitions in the decay of ^{133}Ba and ^{139}Ce were obtained. The factor $\omega_K\epsilon_K$ was measured independently by means of K-conversion electron–K-x-ray coincidences, and was then used to determine P_K, the K-capture probability. The independent measurement of the product $\omega_K\epsilon_K$, together with recent accurate values of ω_K, provides a new method for the accurate calibration of semiconductor x-ray detectors. In the decay of ^{139}Ce, a value of $P_K = 0.78 \pm 0.03$ was found (where the error represents twice the standard deviation), from which $Q_{EC} = 326^{+7}_{-30}$ keV to the ^{139}La ground-state is found by use of theory. In ^{133}Ba decay, values are found of $P_{K_1} = 0.72 \pm 0.04$ for the EC transition to the 437-keV level in ^{133}Cs, $P_{K_2} = 0.80 \pm 0.07$ to the 384-keV level, and, from an independent measurement, the ratio $P_{K_1}/P_{K_2} = 0.87 \pm 0.007$. From these results the ground-state value of $Q_{EC} = 522^{+20}_{-10}$ keV is derived from theory for ^{133}Ba decay. The γ spectrum of ^{133}Ba also was remeasured. From the present γ intensities and previous conversion electron intensities, new values for K-shell conversion coefficients are obtained. Previously reported γ-rays at 35 and 391 keV are not confirmed. (3 tables) (auth)

19321 DECAY ^{107}In → ^{107}Cd. Rivier, J.; Moret, R. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A177: No. 2, 379-92(1971). (In French).

The excited levels of ^{107}Cd were investigated from the decay of ^{107}In with high-resolution Ge(Li) and Si(Li) detectors. ^{107}In was produced by (p,xn) reaction on natural cadmium and by (p,2n) reaction on enriched ^{108}Cd. Several new transitions are assigned to the decay of ^{107}In. Based on γ–γ coincidence results, a consistent level scheme of ^{107}In is given. The spin and parity assignments of some of the low-lying excited levels of ^{107}Cd are discussed. (5 figures, 3 tables) (auth)

19322 FRACTIONATION OF THE PAIR VIBRATIONAL STATE IN ZIRCONIUM. Soerensen, Bent (Univ. of Copenhagen). Nucl. Phys.; A177: No. 2, 465-83(1971).

The couplings between the pair vibrational 2p–2h state in ^{90}Zr and the two-phonon surface oscillations of multipole order 2, 3, and 5 are evaluated with due consideration taken of nonorthogonality. The resulting distribution of neutron pair correlations is in agreement with two-nucleon-transfer data. The disappearance of the pair vibration in isotopes away from the neutron major-shell closing is explained by consideration of anharmonic pairing correlations. (auth)

19323 COLLECTIVE STRUCTURE OF THE INTERMEDIATE NUCLEI ^{78}Se AND ^{102}Ru. Holzwarth, G.; Lie, S. G. (Technische Univ., Garching, Ger.). Z. Phys.; 249: No. 4, 332-48(1972).

By assuming an expansion of the E2-transition operator in terms of dynamical bosons, the formulas for E2 matrix elements are pre-

sented and applied to the intermediate nuclei ^{78}Se and ^{102}Ru. The comparison with measured ratios of transition strengths seems to indicate that Bose expansions up to the fourth order are sufficient for the description of strongly anharmonic nuclei. The anharmonicities in the corresponding kinetic and potential energies are determined by the definition of collective normal coordinates. (7 figures, 10 tables) (auth)

19324 EFFECTIVE COUPLING CONSTANT FOR THE M2 TRANSITION FROM THE $1h_{11/2}$ TO THE $1g_{9/2}$ STATE IN ^{143}Pm. Ejiri, H.; Shibata, T.; Satoh, K. (Osaka Univ.). Phys. Lett.; 38B: No. 2, 73-4(24 Jan 1972).

The half-life of the 959-keV $11/2^-$ state in ^{143}Pm was measured as 26.0 ± 1.2 ns. This gives the effective M2 coupling constant $g_{M2}^{eff} = 0.235\ g_{M2}^{SP}$ for the $1h_{11/2} \rightarrow 1g_{9/2}$ transition, a result suggesting a reduction due to spin-isospin core polarization. (auth)

19325 COMPARISON OF SPECTROSCOPIC FACTORS FROM ^{95}Mo(d,t)^{94}Mo AND ^{94}Mo(p,p′γ)^{94}Mo EXPERIMENTS. Abramson, E. (Weizmann Inst. of Science, Rehovot, Israel); Engler, G.; Vager, Z.; (and others). Phys. Lett.; 38B: No. 2, 70-2(24 Jan 1972).

Spectroscopic factors from the ^{95}Mo(d,t)^{94}Mo reaction were compared with partial decay strengths obtained from the ^{94}Mo(p,p′γ)^{94}Mo reaction proceeding through the $5/2^+$ g.s. analog resonance. The results of the comparison support the treatment of the compound enhancement applied in the analysis of the ^{94}Mo(p,p′γ)^{94}Mo reaction. (auth)

19326 LEVEL SPECTRA OF NUCLEI WITH $51 \leq Z \leq 61$ AND THE INTERMEDIATE-COUPLING MODEL. De Pinho, A. G.; Goldstein, I. V.; Jeronymo, J. M. F. (Pontificia Univ. Catolica, Rio de Janeiro). An. Acad. Brasil. Cienc.; 43: No. 1, 63-95(Mar 1971).

The properties of the low-lying levels of many odd-mass nuclei with $51 \leq Z \leq 61$ were studied in the framework of the unified (intermediate-coupling) model. Energies, magnetic dipole and electric quadrupole moments, transition probabilities and spectroscopic factors were calculated and compared with the experimental values. Up to three phonons and four shell-model orbits were considered in the calculation of the positive parity states. The A dependence of the adjustable parameters of the model was examined. (35 figures, 8 tables, 88 references) (auth)

19327 GAMMA–GAMMA ANGULAR CORRELATIONS IN ^{125}Te. Badica, T.; Dima, S.; Gelberg, A.; Popescu, I. (Inst. for Atomic Physics, Bucharest). Z. Phys.; 249: No. 4, 321-6 (1972).

Angular correlation measurements of the γ transitions coincident with the 35.5-keV transition in ^{125}Te were carried out with Ge(Li)–Si(Li) detectors. Mixing ratios for some of the transitions were determined. (3 figures, 2 tables) (auth)

19328 SCATTERING OF 185 MeV PROTONS FROM ^{90}Zr. Hagberg, E.; Ingemarsson, A.; Sundqvist, B. (Univ. of Uppsala). Phys. Scr.; 3: No. 6, 245-53(1971).

Differential cross sections and polarizations for elastic and inelastic scattering of 185-MeV protons from ^{90}Zr were measured in the angular region between 6 and 40° (lab. system). Optical model analyses of the elastic scattering data were performed. A qualitative discussion of the results for the inelastic scattering is given, which is based mainly on the shapes of the angular distributions. Comparisons are made with relevant results from other experiments on inelastic scattering in ^{90}Zr and lighter nuclei. (auth) (Sweden)

19329 IN-BEAM γ-RAY MEASUREMENTS OF THE EXCITED STATES IN ^{103}Pd FROM THE ^{103}Rh(p,nγ)^{103}Pd REACTION. Matthews, Dennis L.; Koike, M.; Moore, C. Fred (Univ. of Texas, Austin). Nucl. Phys.; A177: No. 2, 577-97(1971).

The reaction ^{103}Rh(p,nγ)^{103}Pd at incident proton energies between 1.4 and 6.3 MeV was used to excite the levels in ^{103}Pd and to study their subsequent γ decay. In-beam singles, anti-Compton, and γ–γ coincidence measurements were made using Ge(Li) detectors, a NaI(Tl) annulus, and an on-line multiparameter data acquisition system. By these methods more than 40 γ rays associated with ^{103}Pd as well as γ–γ coincidence spectra gated by 18 separate γ transitions were observed. Excited states at 118.9, 243, 266, 294, 504, 531, 625, 698, 716, 726, 884, 900, 913, 1042, 1068, 1183, and 1277 keV were identified by these measurements. The triplets of states at 697–716–726 and 884–900–913 keV have not been resolved by previous experiments. Probable spin and parity assignments are suggested for some of the levels. Branching ratios are determined along with a decay scheme for ^{103}Pd. (8 figures, 3 tables) (auth)

19330 NEUTRON RESONANCES IN BARIUM ISOTOPES. Van De Vyver, R. E.; Pattenden, N. J. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys.; A177: No. 2, 393-400(1971).

The neutron transmissions of enriched samples of ^{134}Ba, ^{135}Ba, ^{136}Ba, and ^{137}Ba were measured for energies from 4 to about 2000 eV. Observed resonances were assigned to particular isotopes, and neutron widths were determined by area analysis. A comparison with recently published data is made. (3 figures, 2 tables) (auth)

19331 EXPERIMENTAL STUDY OF NUCLEAR LEVELS OF ^{140}Ce FORMED IN DECAY OF ^{140}La. Ardisson, G.; Marsol, C. (Institut d'Etudes Nucleaires, Algiers). Rev. Roum. Phys.; 16: No. 9, 1045-58(1971). (In French).

The β decay of ^{140}La was re-examined by means of a pair spectrometer, of which the central detector was a Ge(Li) diode, as well as with conventional spectrometers. Thirty-two γ rays are reported of which 8 are new. The internal conversion coefficients of a great number of transitions are calculated on the basis of the γ data of this work, and the multipole orders are evaluated in the majority of the cases. A decay scheme of ^{140}La is proposed and the excited levels of ^{140}Ce are discussed; two new levels are suggested at 2494 and 3474 keV. The lifetime of the 3^- octupole level of ^{140}Ce is deduced, its value being $T_{1/2} = (0.10 \pm 0.06)$ ps. The E1 transition which de-excites it is hindered by a factor of 260. (7 figures, 2 tables) (tr-auth)

19332 SUB-COULOMB STRIPPING IN THE ^{124}Sn(d,p)^{125}Sn REACTION. Powell, D. L.; Dallimore, P. J.; Davidson, W. F. (Australian National Univ., Canberra). Aust. J. Phys.; 24: No. 6, 793-803(Dec 1971).

Angular distributions for the reaction ^{124}Sn(d,p)^{125}Sn leading to the unresolved ground and 0.026 MeV levels and to the 0.210, 0.936, 1.257, 1.362, and 1.540 MeV levels of ^{125}Sn have been measured with deuteron energies of 5.1 and 12.0 MeV. Spectroscopic factors have been extracted using the DWBA theory. The dependence of the calculations on various assumptions of the theory has been studied by comparing the results at both energies. The sub-Coulomb data have been found to yield more reliable spectroscopic factors because of the lack of sensitivity to the optical model parameters used in the distorting potentials. (auth) (Australia)

19333 WEAK TRANSITIONS IN THE DECAY OF $^{110\,m}$Ag. Phillips, G. B. (Vanderbilt Univ., Nashville); Brahmavar, S. M.; Hamilton, J. H.; Kracikova, T. Nucl. Phys.; A182: No. 3, 606-18(1972).

The γ-ray spectra from the decay of $^{110\,m}$Ag was measured with a 50 cm^3 Ge(Li) detector at Vanderbilt University to search for weak transitions. Similar studies with a smaller detector were carried out at Charles University. In addition to the 15 well-known, relatively strong transitions in this decay, 18 weak transitions were definitely established. Six of these were fitted into levels at 1783.5 and 2561.3 keV which previously were unreported in the decay of $^{110\,m}$Ag. Some unaccounted for transitions were also observed. (auth)

19334 DELAYED-PROTON EMISSION AND STRENGTH FUNCTION PHENOMENA IN NUCLEAR BETA DECAY. Hansen, P. G. (CERN, Geneva. Univ. of Aarhus, Denmark). Proc. Nucl. Phys. Solid State Phys. Symp.; 1: 1-8(1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970).

Some research on delayed proton emission and strength functions in the β decay of highly neutron-deficient nuclei performed at the ISOLDE facility is briefly reviewed. (J.W.R.)

19335 NUCLEAR MOMENTS AND HYPERFINE FIELDS. Baba, C. V. K. (Bhabha Atomic Research Centre, Trombay, India). Proc. Nucl. Phys. Solid State Phys. Symp.; 1: 9-26 (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970).

Some recent developments in the use of very large hyperfine fields in measurements of nuclear magnetic moments by the perturbed-angular-correlation method are surveyed. Hyperfine fields at impurity sites in ferromagnetic lattices, transient magnetic fields, and hyperfine fields in highly ionized atoms are discussed. (J.W.R.)

19336 METHOD FOR MEASURING THE SPIN DEPENDENCE OF THE CROSS SECTION FOR THE (n,γ) PROCESS. Weise, K. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods; 99: No. 1, 35-43(1972). (In German).

The ratio $\sigma_{a,I+1/2}/\sigma_{a,I-1/2}$ of the cross sections for the (n,γ) process at low neutron energies outside the resonances and for the different total angular momenta $J = I \pm 1/2$ of the neutron-target nucleus system for nuclei with ground state spin $I \neq 0$ can simply be de-

rived from the integral $\nu = \int F(U)Z(U)dU$, which has to be determined by means of polarized neutrons and oriented nuclei in a thin target for two different degrees of neutron polarization. Z(U) is a linear combination of the gamma radiation pulse height spectra measured at two definite angles to the direction of the nuclear orientation. F(U) is widely arbitrary if the function Z(U) varies only little except for normalization, when neutron polarization is altered. (auth)

19337 UNIFIED MODEL IN INTERMEDIATE COUPLING APPLIED TO THE ODD-MASS ISOTOPES OF INDIUM. Atalay, B. I.; Chiao-Yap, L. W. (Georgetown Univ., Washington, D. C.). Phys. Rev., C; 5: No. 2, 369-81(Feb 1972).

The unified model in intermediate coupling has been applied to the odd-mass isotopes of indium $^{109-117}$In. By using three free parameters, the dimensionless interaction parameter, ξ, the effective 2^+ phonon energy of the core, $\hbar\omega$, and the single-particle energy separations, E_j, theoretical energy spectra were fitted to the experimental spectra. The wave functions obtained during the diagonalization of the Hamiltonian were used in calculating magnetic dipole moments for the ground and first excited states, the quadrupole moments of the ground states, and M1 and E2 reduced transition probabilities for transitions between the second and first excited states. In reproducing the observed values of the magnetic dipole and electric quadrupole moments, effective values of the spin g factor and interaction strength parameter were employed. These were found to vary remarkably smoothly with the mass number A. The following values for the hitherto unmeasured properties of the indium isotopes are predicted: magnetic moment of the ground state of ^{117}In, $5.516\mu_N$; the quadrupole moment of the ground state of ^{117}In, 1.057×10^{-24} cm^2; and the B(M1) and B(E2) values for ^{113}In for the decay of the second excited state to the first excited, $0.708e^2 \times 10^{-38}$ cm^2 and $0.149e^2 \times (10^{-24}$ cm$^2)^2$, respectively. The results compare favorably with those obtained by other investigators who used other models. (8 figures, 9 tables) (auth)

19338 LEVELS IN THE N = 82 NUCLEUS ^{138}Ba POPULATED IN ^{138}Cs DECAY. Hill, John C.; Fuller, D. F. (Texas A and M Univ., College Station). Phys. Rev., C; 5: No. 2, 532-43(Feb 1972).

The decay of ^{138}Cs to levels in the 82-neutron isotone ^{138}Ba was investigated with Ge(Li) and NaI(Tl) γ detectors. On the basis of energy, intensity, and coincidence measurements a new decay scheme is proposed including 31 levels. States of 2090, 2415, 2779, 2931, 2991, 3164, 3352, 3442, 3647, 3861, 3880, 3935, 4081, and 4507 keV were not seen in earlier studies of the ^{138}Cs ground-state decay. Spin assignments were made for all levels. The level scheme is compared with the results of recent decay and reaction experiments and with the predictions of shell-model calculations. (auth)

19339 PROTON SPIN-FLIP PROBABILITY IN INELASTIC SCATTERING ON ^{120}Sn AND ^{124}Sn AT 30 MeV. Howell, R. H.; Galonsky, A. I. (Michigan State Univ., East Lansing). Phys. Rev., C; 5: No. 2, 561-7(Feb 1972).

Proton spin slip in the excitation of the first 2^+ states in ^{120}Sn and ^{124}Sn was measured at 30 MeV by using the (p,p'γ) coincidence technique. The data were fitted by the distorted-wave Born-approximation (DWBA) collective model with the full Thomas spin-orbit coupling term and the DWBA microscopic model with a real interaction. The effect of adding an imaginary part to the microscopic interaction was investigated with respect to the present spin-flip data and published asymmetry data. It is concluded that such a term can be important. (8 figures, 1 table) (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 17832, 19287, 19304, 19336, 19422, and 19446.

19340 EXPERIMENTS ON MEASUREMENT OF THE LIFETIME OF THE COMPOUND NUCLEUS IN THE REACTION W (^{22}Ne,f). Karamyan, S. A.; Oganesyan, Yu. Ts.; Normuratov, F. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 3, 499-506(Sep 1971). (In Russian).

Decrease in the shadow path in the angular distribution of fission fragments is observed in irradiation of a W monocrystal by ^{22}Ne ions with the energy of 115 to 174 MeV; the decrease is due to a finite lifetime of the compound nucleus. No similar effect was observed for the reaction W(^{16}O,f) at an energy of 137 MeV. The instrumental shadow depth was measured by observing the shadow at an angle of $\theta = 160°$, when the ion-beam direction and the target crystallographic axis are oriented at a small mutual angle (20°). An approximate value of the lifetime of the compound nucleus in the reaction W(^{22}Ne,f) at E = 174 MeV amounts to 2.5×10^{-18} sec. The main uncertainty is due to the fact that, in irradiation of the natural mixture of the W isotopes, several fissionable nuclei with different values of A are present. (5 figures, 1 table) (auth)

19341 LOW SPIN STATES IN ^{181}Hf FROM THE THERMAL NEUTRON CAPTURE REACTION. Alenius, G.; Arnell, S. E.; Schale, C.; Wallander, E. (Chambers Univ. of Tech., Goteborg). Phys. Scr.; 3: No. 3-4, 105-10(1971).

The energies and intensities of gamma radiation from thermal neutron capture in an enriched sample of ^{180}Hf have been determined by means of a Ge(Li) pair and anti-Compton spectrometer. An internal reactor target has been used. The reaction Q-value, the energies of the excited states and the decay scheme of ^{181}Hf have been deduced. A large number of low K-value states are found in the range of excitation energy from 1 to 2 MeV. (auth)

19342 ELECTRON–GAMMA DIRECTIONAL CORRELATIONS IN ^{168}Er. Hasselgren, L.; Sahota, H. S.; Thun, J. E.; Falk, F. (Uppsala Univ.). Phys. Scr.; 3: No. 3-4, 119-23(1971).

Transitions in the decay of ^{168}Tm to ^{168}Er have been studied by measurements of electron-gamma directional correlations. The M1-contributions of the 632-, 731- and 816-keV transitions between the gamma-vibrational band and the ground state rotational band have been determined to amount to less than 0.8%. The 99-, 198- and 830-keV transitions depopulating the 1094-keV state have been determined to be of predominantly E1-character. A pure E1-multipolarity for the 99-keV transition is however possible only if a penetration effect is present in the internal conversion process characterized by a nuclear current parameter. (auth)

19343 B(E2) OF THE FIRST 2+ LEVEL OF ^{150}Sm. Cameron, J. A.; Zamori, Z. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: No. 21, 2690-2(1 Nov 1971).

The cross section for the inelastic scattering of ^{4}He ions exciting the first 2+ state of ^{150}Sm was compared with the cross section for elastic scattering. From the measured ratios at 9 and 10 MeV bombarding energy, the reduced transition probability was found to be B(E2; O+ → 2+) = 1.33 ± 0.03 e^2b^2. (auth) (Canada)

19344 EXCITATION FUNCTIONS AND RECOIL RANGES OF REACTIONS INDUCED IN ^{181}Ta WITH 40 TO 110 MeV ^{11}B IONS. Delagrange, H.; Fleury, A.; Hubert, F.; Simonoff, F. N. (CEN, Bordeaux). Phys. Lett.; 37B: No. 4, 355-7(13 Dec 1971).

Excitation functions and mean recoil ranges are reported for formation of ^{188}Pt, ^{186}Ir, ^{185}Os, ^{182}Re, ^{181}Re, ^{182}Ta from ^{11}B bombardment of ^{181}Ta. The stacked foil technique is used. The results show two reaction mechanisms: compound nucleus formation and direct transfer. (auth)

19345 693 keV $2^{+\prime} \rightarrow 2^+$ TRANSITION IN ^{154}Gd. Marinkov, L.; Bikit, I.; Anicin, I.; (and others) (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Z. Phys.; 248: No. 4, 345-54(1971).

The multipolarity of the $2^{+\prime} \rightarrow 2^+$ transition in ^{154}Gd has been investigated. The correlation coefficient $A_{22} = -0.04 \pm 0.10$ was determined on an electron–gamma directional correlation spectrometer, while the conversion coefficient $\alpha_K = 0.046 \pm 0.002$ was deduced by comparing the normalized electron and gamma intensities. From these values the quantities δ, q_K and X were calculated and compared with the theoretical predictions. (auth)

19346 DETERMINATION OF THE L-SHELL CONVERSION COEFFICIENT FOR THE 26 keV MOESSBAUER TRANSITION IN ^{161}Dy. Steiner, P.; Weyer, G. (Freie Univ., Berlin). Z. Phys.; 248: No. 4, 370-4(1971).

The L-shell conversion coefficient of the 26 keV Moessbauer transition in ^{161}Dy has been determined to be $\alpha_L = 2.4^{+0.3}_{-0.3}$ by coincidence techniques using high resolution Ge(Li) and Si(Li) detectors. With theoretical values for the M- and N-shells the total conversion coefficient is calculated to be $\alpha_{tot} = 2.9^{+0.3}_{-0.2}$. (auth)

19347 MUONIC ISOMER SHIFTS IN ^{153}Eu. A RE-EVALUATION OF MOESSBAUER ISOMER SHIFTS IN RARE EARTHS. Walter, H. K.; Backe, H.; Engfer, R.; (and others) (CERN, Geneva). Phys. Lett.; 38B: No. 2, 64-6(24 Jan 1972).

Muonic isomer shifts of five γ-ray transitions in ^{153}Eu were measured, and the changes of the mean square radius between the ground and excited states were derived. With the present data the Moessbauer isomer shifts in rare earths can be re-evaluated. (auth)

19348 PERTURBED-ANGULAR-CORRELATION INVESTIGATION OF THE ATOMIC AFTEREFFECTS OF BETA DECAY

IN ^{160}Tb. Lopiparo, Peter Carl. Philadelphia; Univ. of Pennsylvania (1971). 128p. University Microfilms Order No. 71-26,053. Thesis.

The time necessary for an atomic shell to adjust to the sudden change in nuclear charge associated with a nuclear particle decay is of fundamental importance in angular correlation measurements on subsequent cascades of nuclear radiation. If this recovery time is long enough for the ionic state of the atom to be uncertain during the intermediate-state lifetime of the nuclear cascade, a corresponding ambiguity in the interpretation of measured hyperfine fields will result. Terbium-160, which β-decays to dysprosium-160, was placed in solids of various electrical conductivities: orthorhombic TbF_3, as an insulator, cubic $Eu_{1-x}Tb_xS$ as a semiconductor, and cubic TbS as a metal. The integral rotation method of perturbed angular correlations was then used to measure the room-temperature paramagnetic enhancement of an external magnetic field at the daughter (dysprosium) nucleus immediately following the β-decay of terbium. Since the paramagnetic correction factor for Dy^{3+} is nearly twice that for Tb^{3+}, this parameter was used to determine whether the atomic aftereffects of the nuclear β-decay persisted long enough to influence the angular correlation measurements. Both time-integral and time-differential measurements were performed on $\gamma-\gamma$ cascades passing through the 2.9-nsec, 87-keV state of ^{160}Dy. The paramagnetic correction factor was found to be independent of the chemical composition of the samples, with a value which corresponded to that predicted for the Dy^{3+} ion. This result indicates that the atomic recovery was complete in times much less than one nanosecond in all the compounds studied. The fast recovery in insulating TbF_3 is discussed on the basis of a simple model. Time-differential studies showed that static quadrupole effects in orthorhombic TbF_3 were completely masked at room temperature by rapidly fluctuating magnetic hyperfine fields due to the 4f-shell of Dy^{3+}. The correlation time of these fluctuations was in the picosecond range and no statistically significant deviation from the Abragam–Pound theory of such fluctuating interactions was found. (Diss. Abstr. Int., B)

19349 LEVEL STRUCTURE IN ^{152}Gd STUDIED IN THE DECAY OF 17.5 h ^{152}Tb. Zolnowski, D. R.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Nucl. Phys.; A177: No. 2, 513-58(1971).

The decay of ^{152}Tb(17.5 h) was studied using Ge(Li) detectors to obtain singles spectra and to perform $\gamma-\gamma$ coincidence experiments. More than 290 transitions are observed, of which about 100 were not previously reported. A revised decay scheme is proposed in which most of the observed transitions are attributed to the decay of 67 proposed states in ^{152}Gd. Experimental internal-conversion coefficients are calculated using previously reported conversion-electron intensities and the γ-ray intensities obtained in this investigation. Branching ratios are compared to those obtained for analogous levels in other transitional nuclei, and an attempt is made to interpret the known level structure of ^{152}Gd in terms of quasi-rotational bands. Quasi β, γ, $\beta\gamma$ and 2β bands, as well as $K = 0$ and $K = 1$ octupole bands, are proposed. A level at 1862.0 keV is interpreted as the 2^+ member of a possible quasi 3β band, while a 2^+ state at 1941.2 keV is interpreted as the bandhead of a possible quasi $(\gamma-2\beta)$ band. (4 figures, 12 tables) (auth)

19350 CALCULATION OF THE PENETRATION FACTOR FOR THE INTERNAL CONVERSION OF MAGNETIC DIPOLE TRANSITIONS IN DEFORMED NUCLEI. Protop, C. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 9, 951-9(1971).

A formula for the reduced matrix element of the penetration operator in the internal conversion of the M1 transition in deformed nuclei is given. Penetration parameters for the 103-keV and 114-keV transitions in ^{153}Eu and ^{175}Lu, respectively, are found using the Hager–Seltzer coefficients. The so-called "anomaly" of the experimental L-subshell ratios is removed in terms of the penetration effect. The agreement between experimental value of the penetration matrix element and its value calculated by the given formula is satisfactory. (1 figure, 2 tables) (auth)

19351 DETERMINATION OF LIFETIMES AND REDUCED TRANSITION PROBABILITIES OF 4+ STATES IN EVEN–EVEN NUCLEI IN THE $150 \leq A \leq 190$ RANGE. Menteshashvili, K. O.; Nabichvrishvili, V. A. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 65: No. 1, 45-8(Jan 1972). (In Russian).

Determination of lifetimes and reduced transition probabilities of 4+ states for 33 even-even nuclei from ^{152}Sm to ^{192}Os was carried out on the basis of the experimental data of reduced probabilities B (E2; $0 \rightarrow 2$) and τ (E2) for 2+ levels of basal rotational band in even-even nuclei and parameters μ and γ. Comparison with well-known experimental values of lifetimes of 4+ states resulted in good coincidence within the limits of errors. (auth)

19352 MULTIPLE COULOMB EXCITATION OF γ-VIBRATIONAL BANDS IN ^{162}Dy, ^{166}Er, ^{168}Er, AND ^{170}Er. Domingos, J. M. (Nuclear Physics Lab., Oxford); Symons, G. D.; Douglas, A. C. Nucl. Phys.; A180: No. 2, 600-14(1972).

The 2_γ and 4_γ states in ^{162}Dy, ^{166}Er, ^{168}Er and ^{170}Er have been Coulomb excited with 45 to 60 MeV ^{16}O ions. Values of B(E2; $0 \rightarrow 2_\gamma$) were determined and the angular correlations of the de-excitation γ-rays in coincidence with the backscattered particles have been analyzed to yield E2/M1 mixing ratios for the $2_\gamma \rightarrow 2$ and $4_\gamma \rightarrow 4$ transitions. From the measured branching ratios for the decay of the 2_γ and 4_γ states, values of z_2, the spin-independent mixing parameter for the γ-vibrational band, were determined. Two additional states having spin and parity assignments 0^+ and 4^+ have been identified in ^{170}Er at energies of 889 and 1124 keV, respectively. (auth)

19353 DECAY OF ^{152}Pm ISOMERS. Ward, T. E.; Morcos, N. A.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem.; 34: No. 1, 13-23(Jan 1972).

Isomers of ^{152}Pm were observed when enriched ^{152}Sm was bombarded with fast neutrons. Production of the isomers was through the ^{152}Sm(n,p)^{152}Pm reaction using 14.8 MeV neutrons. The β- and γ-ray decay of the isomers were studied using an 8-cm^3 Ge(Li) spectrometer and scintillation detectors. Half-lives of the ground and isomeric states were determined to be 3.8 ± 0.5 and 7.55 ± 0.70 min, respectively. The 3.8 min isomer was observed to decay to the ground state, first excited 2^+ state, and to the β- and γ-vibrational states of ^{152}Sm. The 7.55 min isomeric state strongly populated a level at 1804.0 keV in ^{152}Sm. A spin-parity of 5^+ or 6^+ was deduced for the 1804.0 keV level. Tentative decay schemes for the ^{152}Pm isomers are proposed. (auth)

19354 MASS AND ENERGY DISTRIBUTIONS FROM 77.3-MeV-^{4}He-INDUCED FISSION OF ^{181}Ta, ^{209}Bi, AND ^{233}U: A TEST OF LIQUID-DROP-MODEL PREDICTIONS. Plasil, F.; Schmitt, H. W. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 5: No. 2, 528-31(Feb 1972).

Thin targets of ^{181}Ta, ^{209}Bi, and ^{233}U were bombarded with 77.3-MeV ^{4}He ions at the Oak Ridge Isochronous Cyclotron. Correlated measurements of kinetic energies of fission-fragment pairs were made, and mass and total-kinetic-energy distributions were obtained. The widths of the distributions were compared with predictions of the liquid-drop model for fission. The trends predicted by theory were observed, but the absolute magnitude of the distribution widths were not in agreement with liquid-drop-model predictions. It is concluded that the liquid-drop model describes fission of relatively light nuclei in general terms, but that it should not be used in those cases where accurate quantitative predictions are required. (2 figures, 1 table) (auth)

19355 NONEXISTENCE OF METASTABLE STATE OF ^{183}Hf. Sabu, D. D. (Grambling Coll., La.). Phys. Rev., C; 5: No. 2, 586-7(Feb 1972).

The metastable state of ^{183}Hf of 91-day half-life was found to be nonexistent on radiochemical separation of hafnium activity from tungsten targets irradiated by 14-MeV neutrons. (auth)

Nuclear Properties and Reactions, $190 \leq A \leq 219$

Refer also to abstracts 17864, 19234, 19257, 19292, 19304, 19336, and 19382.

19356 NEUTRON ACTIVATION CROSS SECTIONS AT 14.4 MeV FOR SOME NATURALLY OCCURRING HEAVY ELEMENTS IN THE REGION $76 \leq Z \leq 82$. Hankla, A. K. (Georgia Inst. of Tech., Atlanta); Fink, R. W.; Hamilton, J. H. Nucl. Phys.; A180: No. 1, 157-76(1972).

Neutron activation cross section sections at 14.4 MeV were determined for isotopes of the following naturally occurring heavy elements: Os, Pt, Au, Hg, Tl and Pb. The mixed-powder method with Ge(Li) γ-detection was used, and the cross sections in mb are as follows. For (n,2n) reactions (m = metastable; g = ground state); ^{192}Os, 1993 ± 200 (m + g); ^{192}Pt, 2035 ± 150; ^{198}Pt, 1009 ± 100 (m); ^{198}Pt, 707 ± 85 (g); ^{197}Au, 151 ± 18 (m); ^{197}Au, 1986 ± 150 (m + g); ^{196}Hg, 1617 ± 160 (m); ^{196}Hg, 363 ± 54 (g); ^{198}Hg, 885 ± 80 (m); ^{198}Hg, 1125 ± 100 (g); ^{200}Hg, 789 ± 120 (m); ^{204}Hg, 2077 ± 166; ^{203}Tl, 1950 ± 200; ^{204}Pb, 1737 ± 140. For (n,n') reactions: ^{199}Hg, 128 ± 20 (m); ^{204}Pb, 51 ± 10 (m). For (n,3n) reactions: ^{197}Au, 61 ± 20. For (n,p) reactions: ^{194}Pt, 4.3 ± 0.6; ^{196}Pt, 1.1 ± 0.2; ^{198}Hg, 4.5 ± 0.5; ^{199}Hg, 2.3 ± 0.3; ^{208}Pb, 0.46 ± 0.06. For the (n,α) reaction; ^{203}Tl, 2.2 ± 0.4. For the [(n,np) + (n,pn) + (n,d)] reaction:

^{199}Hg, 0.40 ± 0.06. Cross sections calculated with the statistical-model equation of Pearlstein and an optimized level-density parameter equation are compared with a consistent set of measured (n,2n) values over the region $30 \leq Z \leq 82$; it is shown that deviations of the calculated cross sections from the respective measured values become larger as the energy needed to emit the second neutron increases, probably because fewer exit channels are available and the continuum assumption in the statistical model of the compound nucleus becomes invalid. (auth)

19357 STRUCTURE OF ^{205}Hg FROM T = $4\frac{5}{2}$ STATES IN ^{205}Tl. Casten, R. F.; Flynn, E. R.; Hansen, Ole; (and others) (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A180: No. 1, 97-109(1972).

The elastic and inelastic proton scattering excitation functions were measured from a ^{204}Hg target at bombarding energies from 14.0 MeV to 16.4 MeV, and at scattering angles of 30.5°, 125°, 149.5° and 165°. The elastic scattering data show T = $4\frac{5}{2}$, l = 4 resonances in ^{205}Tl at 14.72 and 15.43 MeV, an l = 2 resonance at 15.81 MeV, and another possible l = 2 resonance apparently at 16.5 MeV, which is near the upper limit of the experiment. The inelastic scattering to the first excited 2^+ state does not exhibit sharp distinct resonances at the first three of these energies, whereas evidence for a strong resonance structure is found corresponding to the 16.5 MeV elastic resonance. The elastic data are analyzed to yield resonance parameters: E_{res}, Γ_{total} and Γ_p for each resonance. The observed splitting of the $g_{\frac{9}{2}}$ and $d_{\frac{5}{2}}$ strength is interpreted in terms of the structure of ^{205}Hg based on the particle-core coupling model. (auth)

19358 LOW-LYING STATES IN ^{191}Ir. Berant, Z.; Burde, J.; Molchadzki, A. (Hebrew Univ., Jeurusalem). Nucl. Phys.; A180: No. 1, 321-31(1972).

Angular correlation measurements were carried out for four cascades in ^{191}Ir, utilizing a Ge(Li) detector and a NaI(Tl) scintillator. A comparison between the γ-spectrum and the electron conversion lines measured with a magnetic spectrometer, yielded the conversion coefficients for the most prominent transitions. From the angular correlation measurements and the measured conversion coefficients results the spin assignment for some levels and the multipolarities of the de-exciting transitions were determined. The experimental results from the present work and from previous investigations, could be accounted for by describing the 82 keV, 129 keV, 179 keV, 343 keV and 539 keV states by particle excited-core wave functions. (auth)

19359 RELATIVE YIELDS OF THE SECONDARY p(α,xn) REACTIONS ON Bi AT THE ENERGIES OF E_p = 120 TO 660 MeV. Chun Khi, Li.; Mal'tseva, N. S.; Mekhedov, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 3, 484-9(Sep 1971). (In Russian).

Yields of $^{203-210}$At isotopes relative to ^{211}At as a function of proton energy were determined by measuring the At α spectra by means of a semiconductor α spectrometer. (3 figures, 2 tables) (auth)

19360 ELECTRON EXCITATION OF LOW-LYING STATES IN ^{208}Pb. Nagao, M.; Torizuka, Y. (Tohoku Univ., Sendia). Phys. Lett.; 37B: No. 4, 383-5(13 Dec 1971).

High-resolution measurements of the differential cross sections for electron scattering from the ground and low-lying states in ^{208}Pb were carried out. The data obtained were compared with theoretical predictions. (auth)

19361 OBSERVATION OF PARITY VIOLATION IN ^{203}Tl BY MEASUREMENT OF THE β−γ DIRECTIONAL CORRELATION. Dydak, F.; Polaschegg, H. D.; Riehs, P.; Weinzierl, P. (Research Center, Seibersdorf, Austria). Phys. Lett.; 37B: No. 4, 375-6(13 Dec 1971).

An accurate method is presented to determine the asymmetric term $A_1 \cos\theta$ in a β−γ directional correlation as well as a control value which should be zero. A measurement for the decay ^{203}Hg → ^{203}Tl yielded $A_1 = -(2.7 \pm 0.7) \times 10^{-4}$ and the control value $+(0.7 \pm 0.8) \times 10^{-4}$. (auth)

19362 ENERGY OF THE $(h_{\frac{9}{2}})^2_{8+}$ LEVEL IN ^{210}Po AND THE EFFECTIVE $h_{\frac{9}{2}}$ PROTON CHARGE. Bergstroem, I.; Fant, B.; Wikstroem, K. (Inst. of Physics, Stockholm). Phys. Scr.; 3: No. 3-4, 103-4(1971).

The energy of the $(h_{\frac{9}{2}})^2_{8+}$ isomeric state in ^{210}Po has been determined from studies of the ^{208}Pb(α,2n)^{210}Po reaction. The value 1556.9 keV was deduced from the known energy of the 6^+ level and the observed $8^+ \rightarrow 6^+$ 83.7 keV transition. For the $h_{\frac{9}{2}}$ proton orbit $e_{eff}/e = 1.52 \pm 0.06$ was obtained by comparing the experimental and theoretical B(E2) values. (auth)

19363 ANALYSIS OF ^{204}Tl LEVEL SCHEME. Fubini, A.; Terrasi, F.; Vata, I. (CNEN, Rome). Lett. Nuovo Cim.; 2: No. 19, 992-6(6 Nov 1971).

The energy levels of ^{204}Tl were studied using thermal neutron capture in ^{203}Tl. The gamma spectrum was measured by a pair spectrometer with a Ge(Li) detector and two NaI(Tl) crystals. A level scheme was developed and compared with (d,p) and (d,t) results. (J.W.R.)

19364 CALCULATION OF SPREADING WIDTHS OF 1^- AND 1^+ COLLECTIVE PARTICLE-HOLE STATES IN ^{208}Pb AND ^{208}Bi. Davidson, A. M. (Univ. of Glasgow). Nucl. Phys.; A180: No. 1, 208-16(1972).

In heavy nuclei collective 1p-1h states occur at an energy which places them in a dense background of more complicated states into which they can decay. The resultant spreading width is calculated for a 1^- state in ^{208}Pb and a 1^+ state in ^{208}Bi. The former is the giant-dipole state and results are in agreement with experiment. The latter is a spin-flip state suggested in connection with Gamow−Teller β-decay and the relatively low widths obtained suggest that it might be visible in suitable experiments. (auth)

19365 FORCE DEPENDENCE OF 0^+ STATES IN ^{208}Bi. Rajewski, J. (Weizmann Inst. of Science, Rehovot, Isral. Nuclear Research Centre, Negev, Israel); Kirson, M. W. Phys. Lett.; 38B: No. 3, 162-6(7 Feb 1972).

The 0^+ energy levels of ^{208}Bi are calculated with the reaction matrix deduced from the Sussex and Tabakin potentials. Special attention is paid to the isobaric analogue of the ground state of ^{208}Pb which comes 4−5 MeV below the experimental value, and is particularly sensitive to the potential. (auth)

19366 DECAY SCHEME OF ^{211}Bi. Da Silveira, E. F.; De Pinho, A. G.; De Barros Leite, C. V. (Pontificia Univ. Catolica, Rio de Janeiro). An. Acad. Brasil. Cienc.; 43: No. 1, 97-111(Mar 1971). (In Portuguese).

The decay scheme of ^{211}Pb was reinvestigated by means of Ge(Li) singles and coincidence techniques; two new levels were added to the known level scheme of ^{211}Bi. A total of 31 transitions were observed following the decay of ^{211}Pb and its daughters, and 21 of these transitions were accommodated in the level scheme of ^{211}Bi. Energies and relative intensities of all the transitions were determined as well as some internal conversion coefficients. The resulting level scheme was compared with a calculation where only the $[(\pi 1h9/2)^1(\nu 2g9/2)^2]$ configuration was considered and the levels were calculated by using only experimental information about the interaction of two 2g9/2 neutrons (from the ^{212}Pb level scheme) and of a g9/2 neutron and an h9/2 proton (from ^{210}Bi). No adjustable parameter was present and some impressive results were attained. (6 tables, 3 figures) (auth)

19367 MONOPOLE ADMIXTURES IN THE $2^{\prime+}$-2^+ TRANSITIONS IN $^{192\ 194\ 196}$Pt NUCLEI. Doubt, H. A.; Hamilton, W. D. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys.; A177: No. 2, 418-32(1971).

A good energy-resolution system employing a Ge(Li) detector and a lens spectrometer was used to measure e−γ and γ−e directional correlations in ^{192}Pt; this system prevented the interference of closely lying transitions. For other correlations in this nucleus and in ^{194,196}Pt a NaI crystal-lens spectrometer combination was used. Particular emphasis was placed on the $2^{\prime+} \rightarrow 2^+ \rightarrow 0^+$ correlations, and evaluation of the E0 : E2 mixing ratio q as a function of penetration parameter λ was carried out. The results obtained are as follows: ^{192}Pt, $-0.23 \leq q \leq 0.46$ with $-15 \leq \lambda \leq 148$; ^{194}Pt, $-0.17 \leq q \leq 0.24$ with $-170 \leq \lambda \leq 270$; ^{196}Pt, $-(0.23^{+0.16}_{-0.26})$ with $-3 \leq \lambda \leq 15$, $0.44^{+0.09}_{-0.10}$ with $56 \leq \lambda \leq 77$. These results are considered to be more realistic than those of earlier experimenters who used incorrect values of the E2 : M1 mixing ratios of these transitions in the evaluation. The γ-e correlation results for ^{194}Pt and ^{196}Pt also indicate that some recent results for the $2^{\prime+} \rightarrow 2^+$ transition are in doubt. (7 figures, 6 tables) (auth)

19368 INELASTIC DEUTERON SCATTERING IN THE LEAD REGION. Ungrin, J.; Diamond, R. M.; Tjoem, P. O.; Elbek, B. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd.; 38: No. 8, 34p (1971).

Elastic and inelastic scattering of 13.1 MeV deuterons from the stable isotopes of Bi, Pb and Tl have been studied. The scattered deuterons were observed at 120°, 125°, and 150° with a high resolution magnetic spectrograph. Angular distributions of the elastically scattered deuterons were measured and fitted with a five-parameter optical model. A number of multiplets in the odd-mass isotopes expected on the basis of a particle-vibrational coupling model were located. Of these, the multiplets corresponding to the strong octupole states near 2.6 MeV were found in all four odd-mass nuclei and an accurate comparison of the relative

population strengths was made. A large decrease in the cross section to the octupole states was observed in going from ^{208}Pb to ^{203}Tl. (auth)

19369 E2/M1 MULTIPOLE MIXING RATIOS OF THE 2'+ → 2+ TRANSITIONS IN ^{192}Pt AND ^{194}Pt. Bashandy, E. (Atomic Energy Establishment, Cairo). Z. Naturforsch.; 26a: No. 7, 1109-11(Jul 1971).

The multipole mixing of 2'+ → 2+ transitions in ^{192}Pt and ^{194}Pt has been determined by measuring the absolute K-internal conversion coefficients. The experiments were performed by means of an iron-free double focusing electron spectrometer and Ge(Li) detector. The measurements yield the following values of the E2 : M1 mixing ratio δ: δ(296) in ^{192}Pt = 6.0 ± 0.5, δ(293) in ^{194}Pt = 6.24 ± 0.55. The results are compared with angular correlation measurements. (auth)

19370 ^{208}Pb(^{3}He,^{3}He') REACTION AT 43.7 MeV. Baker, F. Todd; Tickle, Robert (Univ. of Michigan, Ann Arbor). Phys. Rev., C; 5: No. 2, 544-9(Feb 1972).

Angular distributions for the (^{3}He,^{3}He') reaction exciting the first 2^+, 3^-, 4^+, and 5^- levels of ^{208}Pb were measured from 13 to 50° at bombarding energy of 43.67 MeV. The data were analyzed using both a collective model and a microscopic model; the microscopic calculations used the wave functions of Gillet, Green, and Sanderson. The distorted-wave Born-approximation calculations do not provide good fits at very forward angles; this problem appears to become more severe with increasing multipolarity. The interference between the Coulomb and nuclear parts of the form factor allows one to measure the phase of the effective microscopic interaction. The results of the present experiment indicate that this phase is near π/3 for the ^{208}Pb(^{3}He,^{3}He') reaction. (3 figures, 2 tables) (auth)

19371 SHELL-MODEL STRUCTURE OF ^{210}Bi: ^{209}Bi(d,p) AT 17 MeV. Kolata, J. J.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., C; 5: No. 2, 568-78(Feb 1972).

The reaction ^{209}Bi(d,p)^{210}Bi was studied at 17.0 MeV incident deuteron energy. Reaction protons were detected with an energy resolution of 7 to 9 keV by using an Enge split-pole spectrograph. Accurate excitation energies (±0.2%) were obtained by a direct comparison to the well-known states of ^{209}Pb populated in the ^{208}Pb(d,p) reaction. The ground-state Q-value difference of ^{209}Bi (d,p) relative to ^{208}Pb(d,p) was found to be +0.662 ± 0.004 MeV. Angular distributions, neutron l-transfer assignments, and spectroscopic strengths were obtained for 53 of the 60 proton groups observed up to an excitation energy of 3.3 MeV in the residual nucleus. It is found that agreement between experimental angular distributions and the predictions of the distorted-wave approximation is markedly improved over previous work in the lead region by the use of real optical-model well parameters that closely satisfy the "well-matching" criterion $V_d(r) \approx V_p(r) + V_n(r)$; in particular, the extreme oscillations predicted for l = 0 neutron transfer with some conventional parameters are damped out, in agreement with experiment. The experimental excitation energies and spectroscopic strengths are compared with the predictions of Kuo and Herling as well as with those of Kim and Rasmussen. Good agreement is found for most of the strong transitions studied. (9 figures, 4 tables) (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 17873 and 19354.

19372 (ANL-7851) SENSITIVITY STUDIES OF THE EFFECT OF UNCERTAINTY IN THE ^{238}U(n,γ), ^{239}Pu(N,f), AND ^{239}Pu(n,γ) CROSS SECTIONS. Hummel, H. H. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 18p. Dep. NTIS.

The effects of current uncertainties in the ^{238}U(n,γ), ^{239}Pu(n,f), and ^{239}Pu(n,γ) cross sections below 1 MeV, believed to be the most serious for fast reactors, were studied for a spherical model of a large LMFBR. Total variations found for a probably pessimistic assumption for ^{238}U σ(n,γ) uncertainty were about 3% in k, 0.10 in breeding ratio, 5% in sodium-void effect (out of a total effect of +2.7% k), and 20% in ^{238}U Doppler effect. For ^{239}Pu σ(n,f) and σ(n,γ) below 30 keV, disagreements among recent measurements (which are usually within error bars) correspond to a variation of about 1% in k, 0.05 in breeding ratio, 15% in sodium-void effect, and 12% in ^{238}U Doppler effect. Uncertainty in the ^{239}Pu fission cross section above 30 keV corresponds to a variation of several percent in k, about a ±5% uncertainty in the sodium-void effect, and minor changes in the other quantities. The most serious of these uncertainties are those in k and in breeding ratio. Improvement in knowledge of low-energy ^{239}Pu cross sections has significantly reduced the uncertainty in reactivity coefficients. (auth)

19373 (KFKI-71-63) FISSION NEUTRON SPECTRUM OF ^{252}Cf FROM 0.002 TO 1 MeV. Jeki, L.; Kluge, Gy.; Lajtai, A.; Dyachenko, P. P.; Kuzminov, B. D. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Nov 1971. 8p. Dep. NTIS (U. S. Sales Only).

Measurement of fission neutron spectra from 0.002 to 1 MeV for spontaneous fission of ^{252}Cf by the time-of-flight technique are reported. The low-energy part of the spectrum shows some deviation from the expected Maxwellian shape. (auth)

19374 (UCI-34-P-126-X-3) GAMMA TRANSITION ENERGIES OF THE MAJOR FISSION PRODUCTS. Report No. 1971-1. Grant, P. M.; Miller, G. E.; Rowland, F. S. (California Univ., Irvine. Dept. of Chemistry). Nov 1971. 26p. Dep. NTIS.

Tabulations are presented for the predominant fission product gamma rays and yields from ^{235}U fission. In addition to a complete presentation as a function of mass number, a second tabulation lists the gamma transitions in the order of increasing photon energy. (auth)

19375 DECAY CURVES AND HALF-LIVES OF GAMMA-EMITTING STATES FROM A STUDY OF PROMPT FISSION GAMMA RADIATION. Albinsson, H. (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Scr.; 3: No. 3-4, 113-17(1971).

Measurements have been made on the time distributions of the prompt gamma radiation emitted from fragments in the thermal-neutron induced fission of ^{235}U. The gamma radiation emitted during different time intervals after the fission event was studied with the help of a collimator, the position of which was changed along the path of the fragments. In this way decay curves were obtained from which half-lives could be estimated. Time components with half-lives of 7.5, 18 and 60 ps were found and their relative intensities were calculated. Half-lives and associated intensities are in good agreement with earlier data from uranium and californium fission. The collimator technique has proved to be effective for determination of half-lives down to less than 10 ps. (auth)

19376 FISSION OF ^{237}Np + n THROUGH A DOUBLE HUMPED FISSION BARRIER. Kolar, W. (Central Bureau of Nuclear Measurements, Geel, Belgium); Theobald, J. P.; Lanzano, G. Z. Phys.; 248: No. 4, 355-61(1971).

The subthreshold fission cross section of neutron induced fission of ^{237}Np has been measured between 20 and 60 eV with the CBNM time-of-flight spectrometer. The resonances in this energy range have been analysed with a single level shape fitting computer program. The result is interpreted in the frame of Strutinsky's theory of nuclear deformation. (auth)

19377 PRODUCTION OF SPONTANEOUSLY FISSIONABLE ^{236}U ISOMER IN THERMAL NEUTRON RADIATIVE CAPTURE. Belov, A. G.; Gangrskii, Yu. P.; Dalkhsuren, B.; Kucher, A. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 4, 685-8(Oct 1971). (In Russian).

Production of spontaneously fissionable ^{236}U isomer with a half life of 70 nsec in thermal neutron radiative capture was observed. Retarded coincidences of conversion electrons emitted in the population of the isomeric state with the fission fragments from the isomer decay were measured. The ratio of cross sections of the isomer production and of induced fission was found to be in the order of magnitude 10^{-4}. There were no other enlightment branching (α particle, conversion electrons) of the ^{236}U isomeric state. (auth)

19378 VARIATIONS OF γ-QUANTA MULTIPLICITY IN FISSION OF ^{235}U BY RESONANT NEUTRONS. Borukhovich, G. Z.; Petrov, G. A.; Teterev, E. N.; (and others) (Ioffe Inst. of Physics and Tech., Leningrad. Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 4, 689-94(Oct 1971). (In Russian).

Variations of the γ-quanta multiplicity in the fission of ^{235}U by resonant neutrons in the energy region up to ~35 eV (the spectrometer resolution is 0.22 μsec/m) were measured on the pulsed reactor of the Joint Institute of Nuclear Research. The mean suspended relative yield of fγγ coincidences for 12 measured resonances were obtained. Separate yields do not reveal statistically large deviations from this mean one. For two possible spin states of compound nucleus (3^- and 4^-) the relative differ-

ence in the yields of the fγγ coincidences is found to be (1.4 ± 0.8)%. With the accuracy achieved, the difference between the mean widths of the (n,γf) process in the fission through compound states with spins $J^\pi = 3^-$ and 4^- does not exceed ~2 MeV. (auth)

19379 DETERMINATION OF THE LIFETIME OF EXCITED COMPOUND NUCLEI IN FISSION USING THE SHADOW EFFECT. Melikov, Yu. V.; Otstavnov, Yu. D.; Tulinov, A. F.; Chetchenin, N. G. (Moscow State Univ.). Nucl. Phys.; A180: No. 1, 241-53 (1972).

The results of three experiments on the observation of the shadow effect in the fission of ^{238}U nuclei in a UO_2 single crystal induced by 1.7 and 3.3 MeV neutrons and 25 MeV α-particles are discussed. Comparison is made of the shapes of the fission-fragment angular distributions in the vicinity of two ⟨111⟩ crystallographic axes directed along and normal to the incident beam. It was found that the displacement of a fissionable nucleus from a lattice site in response to the momentum of the incident particle affects the shape of the shadow. The values of the lifetime of the ^{239}U compound nucleus were found to be $(3.5 \pm 1.0) \times 10^{-16}$ sec at an excitation energy of 6.5 MeV and $(2.0 \pm 0.8) \times 10^{-16}$ sec at 8.1 MeV. (auth)

19380 MEASUREMENTS OF FISSION γ-RAY POLARIZATION. Val'skii, G. V.; Pleva, Yu. S. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 14: No. 3, 507-13(Sep 1971). (In Russian).

Linear polarization of γ rays accompanying fission of ^{235}U induced by slow neutrons was measured by means of a Compton polarimeter. The measurements were done for the γ quanta emitted normal to the fragment-separation axis. The electric field vector E is found to be presumably parallel to this axis. The mean polarization coefficient is found to be 0.15, and its dependence on the γ-ray energy in the interval 0.2 to 2 MeV is very similar to that observed before for the angular anisotropy coefficient. On the basis of the data obtained, a conclusion on the major role of E2 transitions in the de-excitation of the fragments is derived. (3 figures) (auth)

19381 ENERGY DEPENDENCE OF AVERAGE KINETIC ENERGY OF FRAGMENTS FROM α-INDUCED FISSION OF ^{232}Th, ^{235}U, AND ^{238}U. Okolovich, V. N.; Pavlov, A. F. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 14: No. 3, 514-18(Sep 1971). (In Russian).

The average kinetic energy $\bar{E}_K^a$ of the fission fragments was measured by means of the relative method using semiconductor detectors for the fission of ^{232}Th, ^{235}U, and ^{238}U induced by α particles with energies 23.5 to 38 MeV. The measured data are compared with the energy $\bar{E}_K^n$ for the neutron-induced fission of ^{235}U and ^{238}Pu. The effect of the angular momentum transferred to the nucleus by the α particles on the energy dependence of the fission-fragment average kinetic energy is exhibited. (2 figures, 2 tables) (auth)

19382 NUCLEAR RAMAN SCATTERING OF 10.83-MeV PHOTONS BY ^{238}U, ^{232}Th, AND ^{209}Bi. Jackson, H. E. (Argonne National Lab., Ill.); Wetzel, K. J. Phys. Rev. Lett.; 28: No. 8, 513-16(21 Feb 1972).

Differential cross sections were measured for the elastic scattering of 10.83-MeV photons by U, Th, and Bi targets and for inelastic scattering to the first excited states of the residual nuclei over a range of scattering angles. The inelastic scattering was found to be significantly weaker than predicted by currently accepted models of the giant dipole resonance. (auth)

19383 FISSION FRAGMENT K X-RAY EMISSION AND NUCLEAR CHARGE DISTRIBUTION FOR THERMAL NEUTRON FISSION OF ^{233}U, ^{235}U, ^{239}Pu, AND SPONTANEOUS FISSION OF ^{252}Cf. Reisdorf, W.; Unik, J. P.; Griffin, H. C.; Glendenin, L. E. (Argonne National Lab., Ill.). Nucl. Phys.; A177: No. 2, 337-78(1971).

The emission of K x rays by fission fragments within ≈ 1 ns after fission was studied as a function of fragment mass and nuclear charge for thermal-neutron-induced fission of ^{233}U, ^{235}U, and ^{239}Pu and spontaneous fission of ^{252}Cf. This work is based on a simultaneous measurement of the fragment kinetic energies to obtain the fragment masses and high-resolution measurement of the characteristic energy spectra of the K x rays emitted by the fragments to determine their nuclear charges. For all four fissioning systems the K x-ray yields per fragment were found to be strongly dependent on nuclear structure. Near closed nuclear shells the K x-ray yields for odd-Z nuclei are enhanced relative to even-Z nuclei. Away from closed shells the K x-ray yields increase rapidly with Z and A, and the odd–even Z-fluctuations diminish. With an approximate parameterization for the dependence of K x-ray yields on Z and A, the average nuclear charges of the primary fragments represented as a linear function of their pre-neutron-emission mass (charge division) and the width of the charge distribution about the average values (charge dispersion) were obtained. The linear charge division functions obtained in this work are in good agreement with existing radiochemical data and with recent β-decay chain-length measurements. The average charge dispersion (before neutron emission) found in this work for $^{235}U(n,f)$ ($\sigma_z = 0.40 \pm 0.05$ charge units) is narrower than the charge dispersion (0.56 ± 0.06) determined radiochemically (after neutron emission). (16 figures, 6 tables) (auth)

19384 SPONTANEOUS FISSION HALF-LIFE OF ^{238}Pu. Hastings, J. D.; Strohm, W. W. (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem.; 34: No. 1, 25-8 (Jan 1972).

The spontaneous fission half-life of ^{238}Pu was measured and found to be $(4.77 \pm 0.14) \times 10^{10}$ yr. The spontaneous fission fragments were counted with silicon surface barrier detectors using commercially available electronic equipment. The spontaneous fission half-life was calculated by comparing the α-to-fission disintegration ratio with the ^{238}Pu α half-life of 87.77 ± 0.03 yr. (auth)

19385 RADIOCHEMICAL DETERMINATION OF CUMULATIVE YIELDS AT MASS 129 IN NUCLEAR FISSION. Birgul, O.; Lyle, S. J. (Univ. of Kent, Canterbury, Eng.). Radiochim. Acta; 16: No. 2, 103-4(Nov 1971).

Some previously reported cumulative yield values for ^{129}Sb in the thermal fission of ^{235}U are revised after a careful re-examination of counter calibrations. (L.T.W.)

19386 THERMAL NEUTRON CAPTURE CROSS-SECTION OF ^{233}U. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 33: No. 11, 3972-4(Nov 1971).

Reference is made to earlier measurements by one of the authors (Cabell, React. Sci. Tech.; 16: 195(1962)). The new results here described were obtained in a similar way, but there were a number of experimental differences: (1) the irradiation positions were in the graphite reflector of the Dido reactor; (2) a 2-yr irradiation was necessary; (3) ^{236}U was used as reference nuclide; (4) no Co monitors were employed, and the absorption of ^{233}U was used as an internal monitor; (5) the samples were mounted on very pure precipitated SiO_2; and (6) the irradiated U was separated from fission products by reversed phase partition chromatography, using TBP on Kel-F. It was concluded, that, after correction for errors, the capture cross-section of ^{233}U for 2,200 m/sec neutrons is 48.33 ± 1.62 b. Recalculation of the earlier results gave 45.8 ± 3.1 b. The current IAEA recommended value is 47.0 ± 0.9 b. (UK)

19387 γ RAYS EMITTED IN THE DECAY OF $^{228}Ac \rightarrow {}^{228}Th$. Herment, Micheline; Peghaire, Alain; Chin Fan Leang (Univ., Grenoble, France). Compt. Rend., Ser. B; 273: No. 18, 801-4 (3 Nov 1971). (In French).

Several levels of ^{228}Th were identified from studies of the direct γ spectrum, together with observations of multidimensional γγ coincidences made using two Ge(Li) detectors. (France)

19388 SUPERHEAVY ELEMENTS. Sobiczewski, Adam (Instytutu Badan Jadrowych, Warsaw). Postepy Fiz.; 22: No. 6, 573-99(1971). (In Polish).

The theoretical and experimental investigations on the problem of superheavy elements corresponding to the mass numbers A ≈ 300 are reviewed. Prospects for existence of even heavier elements are discussed. (17 figures, 1 table, 55 references) (auth)

19389 MEASUREMENT OF THE LOW ENERGY SPECTRUM OF DELAYED NEUTRONS FROM ^{87}Br AND ^{88}Br PRECURSORS. Chrysochoides, N. G.; Anoussis, J. N.; Mitsonias, C. A.; Perricos, D. C. (Democritus Nuclear Research Centre, Athens). J. Nucl. Energy; 25: No. 11, 551-6(Nov 1971).

Results of the low energy spectrum measurements of delayed neutrons from ^{87}Br and ^{88}Br precursors are reported. ^{235}U was irradiated in the thermal column of Democritos 1 MW swimming pool reactor, and bromine isotopes were separated from fission products by a fast radiochemical technique. Measurements were based on a fast time-of-flight beta-neutron coincidence technique, using as detectors the Nuclear Enterprises plastic scintillators NE-102A with a rise time less than 3 nsec. In this technique, the energy resolution becomes satisfactory for the particular requirements of an experiment by suitably choosing the neutron flight distance and the resolving time of the system for a given energy range of interest. In the present experiments the energy resolution was 9% at worst (150 keV), becoming better and better with decreasing neutron energy (5% at 50 keV). Analysis of the obtained data gave a spectrum with several peaks, which could be possibly composed of discrete lines. Specifically, for the

mixture ^{87}Br and ^{88}Br the peaks appeared at 65–70, 80, 105 and 145 keV, while for ^{87}Br there were indications for peaks at 45, 70 and 110 keV. (auth) (UK)

Nuclear Theory

Refer also to abstracts 18802, 18878, 18905, 19148, 19302, 19308, and 19684.

19390 (JINR–E4-6097) DENSITY OF STATES IN THE ONE-DIMENSIONAL HUBBARD MODEL. Eik, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 14p. Dep. NTIS (U. S. Sales Only).

For the one-dimensional Hubbard model with nearest-neighbor interaction a functional equation is derived, which gives an exact solution for the density of states $D_\sigma(\omega)$. This functional equation is numerically solved for different values of the electron density n_σ and the interaction U. From the resulting behavior of the density of states, band splitting and an effective band narrowing is obtained. In the limit $U \to \infty$ the band splits into several separate peaks. (auth)

19391 (JINR–E4-6127) PAIR CORRELATIONS AND COLLECTIVE 0^+ STATES OF NUCLEI. II. Kartavenko, V. G.; Jolos, R. V.; Doenau, F.; Janssen, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 19p. Dep. NTIS (U. S. Sales Only).

A finite boson representation of fermion operators was obtained for the Hamiltonian with pairing forces in the system of two kinds of nucleons. A collective Hamiltonian, describing pair excitations, was constructed. The case of the strong pair correlations was analyzed. In this case the basis functions were obtained for the expansion of the exact solution. (auth)

19392 (RLO–1388-150) MIRROR ASYMMETRY IN GAMOW–TELLER TRANSITIONS OF LARGE FT-VALUE. Wilkinson, D. H. (Washington Univ., Seattle). [1971]. 14p. Dep. NTIS.

The several single-nucleon wave functions appropriate to the several parent states of a β-decaying nucleus are different in that they must reflect the several separation energies. These differences engender differences between the overlap integrals that enter into the β-transition amplitudes which will therefore themselves differ as between the negaton- and positon-emitting members of an isobaric mirror since the separation energies differ on the two sides of the mirror. The question is asked as to how large this effect may be in cases where, because of strong cancellation between parents, the ft-value is large and so where this asymmetry due to binding energy differences will be largest. The question is answered via a Monte Carlo approach: it is shown that large log ft-value differences may indeed be expected but that the effect is not large enough to account for the differences found in the A = 14 and 32 systems. This conclusion agrees with that made earlier in relation to the small ft-value differences found between mirror transitions of normal ft-value. (auth)

19393 (RLO–1388-151) EVAPORATION SPECTRA. Halpern, I. (Washington Univ., Seattle. Dept. of Physics). [1970]. 14p. Dep. NTIS.

The discussion of evaporation spectra covers problems in the analysis, charged-particle spectra at high energies in heavy nuclei, spectra at lower excitations, inverse cross sections, angular momentum effects on spectra, and the direct component in reaction spectra. (J.F.P.)

19394 PROBLEM OF THE RIGID ROTATOR AND COLLECTIVE STATES OF EVEN–EVEN NUCLEI. Gai, E. V.; Rabotnov, N. S. (Physical Energy Inst., Moscow). Yadern. Fiz.; 14: No. 3, 519–25(Sep 1971). (In Russian).

It is shown that the perturbation series in a recursive formulation may be used for exact solution of the partial eigenvalue problem of the asymmetric rigid quantum-mechanical rotator. The series coverges for all levels of the ground-state rotational band with arbitrarily large angular momentum in the general case of three arbitrary moments of inertia. When comparing the results with the experimental data on even–even nuclei, the fact is consecutively used that in essence the solution depends on only one parameter, a dimensionless combination of the moments of inertia. The comparison shows that, for a reasonable description of levels of the ground-state rotational band, the model in most cases predicts rather overestimated energies for levels of the "anomalous" rotational band as compared with observation. (2 figures, 1 table) (auth)

19395 INFLUENCE OF LOW-LYING 2^+ STATES ON PROPERTIES OF NUCLEI. Malov, V. V. (All-Union Correspondence Inst. of Textile and Light Industry, Moscow). Yadern. Fiz.; 14: No. 3, 526–35(Sep 1971). (In Russian).

Corrections to various physical quantities (energy gap, chemical potential, energy of the odd system, quadrupole moment, etc.) due to a presence in the system of a low-lying 2+ state are calculated and analyzed. The role of the particle–particle and particle–hole channels in the calculation of properties of the 2+ states is discussed. A sum rule for the B(E2) transition from any phonon state is obtained. (auth)

19396 TREIMAN–YANG CRITERION FOR (p,2p) REACTIONS. Kolybasov, V. M.; Smorodinskaya, N. Ya. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 3, 590–5(Sep 1971). (In Russian).

Applicability of the Treiman–Yang criterion for the (p,2p) process is discussed for the case when the reaction amplitude is represented as a sum of the pole amplitude and an additional term approximating contributions from more complicated graphs. The Treiman–Yang angle distribution is obtained, and it is shown that for a number of nuclei the deviation from the isotropic distribution may be very significant. (2 figures) (auth)

19397 INTERFERENCE OF PARTICLES IN PROCESSES INVOLVING EXCITED NUCLEI. Grishin, V. G.; Kopylov, G. I.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 3, 600–6(Sep 1971). (In Russian).

Interference phenomena in nuclear reactions proceeding via intermediate isolated excited states are discussed. Principal possibility of determining the width of the excited state in this way is shown. (auth)

19398 SINGLE-NUCLEON ENERGIES FOR SINGULAR POTENTIALS. Dieperink, A. E. L.; Brussaard, P. J.; Cusson, R. Y. (Duke Univ., Durham, N. C.). Nucl. Phys.; A180: No. 1, 110–30(1972).

Some single-nucleon models for a many-body system are investigated. In particular the singularities are considered which appear in a single-nucleon potential when the nucleon–nucleon interaction has an infinitely hard core. It is demonstrated, in terms of a perturbation expansion, that these singularities occur in the particle density of the single-nucleon potential (the so-called particle–particle energies) or, in terms of Green functions, that they are caused by the singular behavior of the derivative G′(t) in the limit $t \to +0$. Various definitions of rearrangement energies are discussed. (auth)

19399 PROLATE-OBLATE EFFECTS IN SCATTERING OF 104 MeV α-PARTICLES FROM DEFORMED NUCLEI. Rebel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A180: No. 1, 332–6(1972).

Measurable effects originating from the sign of the quadrupole deformation are studied for the scattering of 104 MeV α-particles and they allow us to differentiate experimentally between prolate and oblate nuclear shapes. (auth)

19400 FURTHER DEVELOPMENT OF THE DYNAMIC COLLECTIVE MODEL OF THE GIANT RESONANCE. Rezwani, Vida (Univ., Frankfurt am Main); Gneuss, Gotthard; Arenhoevel, Harmuth. Nucl. Phys.; A180: No. 1, 254–72(1972).

The collective description of the giant dipole resonance has been extended by the inclusion of the recently developed treatments of the collective motion, which can deal with nuclei of quite different collective behavior. Gamma-absorption and γ-scattering cross sections have been calculated for a series of nuclei whose low-energy spectra resemble a transition from a spherical to a deformed nucleus and for a few other examples of nuclei with interesting collective properties. The intermediate structure of the giant dipole resonance is determined in a characteristic manner by the low-energy collective behavior. (auth)

19401 POTENTIAL ENERGY OF A SYSTEM OF TWO NUCLEI, NUCLEAR MOLECULES, AND NUCLEAR FISSION. Shigin, V. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 4, 695–704(Oct 1971). (In Russian).

In the framework of the statistical nuclear model the potential energy of the two-nucleus system is calculated by means of a computer. The result is that in most systems a potential well with corresponding molecule-like states arises. The ground energy of the molecule is near the ground level of the nucleus produced in the fusion of the constituent nuclei. The nuclei may exchange nucleons. The separation barrier for the nuclei decreases with rise of the Coulomb repulsion of the nuclei. Due to these properties of the molecules, at excitations of a heavy nucleus ≈5–10 MeV conditions arise for the fission through the molecular states

produced by the nucleus. The fission stages are as follows: a light nucleus is created within the diffuse edge of the fissible nucleus, the created nucleus grows gaining nucleons from the partner nucleus, the molecule of nuclei with comparable sizes dissociates. (auth)

19402 STATES WITH $K^{\pi} = 1^{+}$ IN DEFORMED EVEN–EVEN NUCLEI OF THE RARE-EARTH REGION. Birbrair, B. L.; Nikolaev, K. N. (Leningrad State Univ.). Yadern. Fiz.; 14: No. 4, 705-14(Oct 1971). (In Russian).

Energies of levels with $K^{\pi} = 1^{+}$ are calculated with account of the presence of spurious states. (auth)

19403 RELATION BETWEEN MATRIX ELEMENTS IN K-HARMONICS METHOD AND IN U(3(A–1))-SCHEME MODEL. Petrauskas, A. K.; Yankauskas, K. I.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Yadern. Fiz.; 14: No. 4, 724-33(Oct 1971). (In Russian).

Transformations between the unitary-scheme and the orthogonal, scheme wave functions and the K-harmonics method basic functions are discussed. One-to-one correspondence between matrix elements in the orthogonal-scheme and in the K-harmonics method is found. The examples of determination of the potential and the spin-orbital energy of nuclei are presented. (auth)

19404 IMPROVED BREMSSTRAHLUNG METHOD FOR STUDYING PHOTOABSORPTION PHENOMENA. Baciu, George (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 7, 711-27(1971).

A brief survey regarding the present status of photoneutron cross-section measurements and the development of photonuclear theories from the point of view of new requirements for improving experimental methods is given. Additional valuable photonuclear experiments using the bremsstrahlung method are indicated. The experimental set-up for the improved bremsstrahlung method is extensively described. (auth)

19405 COMPUTATION OF TOTAL, DIFFERENTIAL, AND DOUBLE-DIFFERENTIAL CROSS SECTIONS FOR COMPOUND NUCLEAR REACTIONS OF THE TYPE (a,b) (a,bγ), AND (a,bγ–γ). III. FORTRAN TRANSLATIONS OF THE ALGOL PROGRAMS MANDY AND BARBARA. Sheldon, E.; Mathur, S.; Donati, D. (Lowell Technological Inst., Mass.). Comput. Phys. Commun.; 2: No. 5, 272-3(Aug-Sep 1971).

MANDYF is a FORTRAN translation of the ALGOL program MANDY. The program calculates total and differential cross sections for compound nuclear reactions of the type (a,b), (a,bγ) and (a,bγ–γ). The method is based on the statistical compound-nucleus theory in j–j coupling formalism. The program is written for the PDP-9 and PDP-10 computers. (J.W.R.)

19406 PROGRAMS TO AID IN ESTABLISHING GAMMA-RAY DECAY SCHEMES, DCSCH3 AND DCSCH4. Foster, B. P. (North Texas State Univ., Denton); Camp, D. C. Comput. Phys. Commun.; 2: No. 5, 288-97(Aug-Sep 1971).

The DCSCH3 and DCSCH4 programs were developed to compute energy-level schemes using measured γ-ray energies and the available known energy levels as input data. The programs are in FORTRAN for the IBM 360-50. (J.W.R.)

19407 PROBLEMS IN APPLYING N–N INTERACTION IN MANY BODY PROBLEMS. Kim, H. (Univ. of Maryland, College Park). Contract AT(40-1)-3491. Phys. Lett.; 37B: No. 4, 347-50(13 Dec 1971).

Problems in the use of two body interactions, determined in the C-M frame of the two bodies, for many body systems are investigated. The effect of the spin rotation due to the coordinate transformation appears as a non-Galilean invariant potential in the spin-orbit interaction and which is the same order of magnitude as the normal spin-orbit interaction. However, it has not been included in the nuclear many body problems. (auth)

19408 NOTE ON THE GARTENHAUS–SCHWARTZ TRANSFORMATION. Palumbo, F. (CNEN, Rome. Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 37B: No. 4, 341-3(13 Dec 1971).

It is shown that the Gartenhaus–Schwartz transformation cannot eliminate spurious effects in shell model calculations. (auth)

19409 FISSION BARRIERS FOR LIGHT ELEMENTS (A = 180 TO 212). Mosel, U. (Univ. of Washington, Seattle); Schmitt, H. W. Phys. Lett.; 37B: No. 4, 335-7(13 Dec 1971).

Fission barriers for elements in the mass range A = 180 to 212 have been calculated in the Two Center Shell Model using the Strutinsky prescription. The theoretical predictions agree well with recent experimental results. (auth)

19410 THEORY OF DEUTERON STRIPPING ON DOUBLY EVEN NUCLEI. Emrich, Kurt (PTechnische Univ., Hanover). Z. Phys.; 248: No. 4, 292-310(1971).

Using the method of quantum Green functions a rigorous formula for the deuteron stripping on a doubly even nucleus is derived. Starting from this formula the distorted-wave Born approximation, some additional assumptions usually made in numerical calculations and the high-energy case are discussed. In addition to this it is shown that the form factor can be calculated using a model for the nucleon self energy. (auth)

19411 DERIVATION OF AN OPTICAL POTENTIAL FOR DEUTERONS. Ueta, K.; Hara, K. (Univ., Heidelberg). Z. Phys.; 248: No. 4, 311-25(1971).

An optical potential for deuterons is derived starting from the nucleon optical potential, taking the deuteron break-up process into account in an approximate way. Numerical calculations have been done for ^{58}Ni (11.8 MeV) and ^{90}Zr (11.8 and 21.4 MeV). The results show that such a process is not at all negligible. (auth)

19412 INELASTIC ELECTRON SCATTERING ON FINITE NUCLEI. Jakob, G. (Ruhr Univ., Bochum, Ger.). Z. Phys.; 248: No. 4, 333-44(1971). (In German).

The response function of a finite nucleus is calculated with the help of perturbation theory. Realistic hard core nucleon–nucleon potentials are used. For the T-matrix elements a Bethe–Goldstone like equation is solved using the method of Kallio and Day. Numerical calculations of the response function are carried out for oxygen. (auth)

19413 REACTIONS IN SYSTEM OF SEVERAL NUCLEONS. Zhukov, M. V.; Efros, V. D. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 3, 577-89(Sep 1971). (In Russian).

Nuclear reactions are considered on basis of the Hulthen–Kohn variational principle. It is shown that the Hulthen–Kohn variational principle in a real form results in an approximate S matrix that is strictly unitary. Various sets of equations are given for the approximate Ψ functions constructed. Comparison with the resonating-group method is carried out. The method is applied to neutron scattering by ^{4}He. (1 figure, 1 table) (auth)

19414 APPLICATION OF STATISTICAL THEORY TO ANALYSIS OF TRIPLE ANGULAR CORRELATIONS IN CAPTURE REACTIONS. Boldyshev, V. F.; Nemashkalo, B. A.; Storizhko, V. E. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 3, 607-14(Sep 1971). (In Russian).

With the assumptions of the statistical model an expression is obtained for the correlation function in particle–γ–γ reactions. Excitation of a large number of levels of the compound nucleus in an interval of the quasi-continuous spectrum is considered. The expression obtained has no interference terms as a result of the assumption of random phase distribution of the matrix elements of production and decay of the compound nucleus. The potentialities of the method are displayed on the example of the p–γ–γ correlation measured for the cascade $E^{*} \rightarrow 0.95 \rightarrow 0$ in the ^{60}Ni(p,γ)^{61}Cu reaction at a proton energy $E_p = 2.5$ MeV. The spin of the 0.95-MeV level, $5/2$, and the mixing ratio, $\delta = 0.28 \pm 0.04$, for the $0.95 \rightarrow 0$ transition, obtained by minimizing the χ_2 functional, are in reasonable agreement with the available data. The ratio of the magnetic to electric dipole transition intensities, populating the 0.95-MeV level, is 0.32 ± 0.16. (5 figures) (auth)

19415 QUADRUPOLE–OCTUPOLE ANHARMONICITIES IN SPHERICAL NUCLEI. Raduta, A.; Sandulescu, A. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 7, 677-703(1971).

On the basis of the conventional shell-model Hamiltonian with pairing, quadrupole, and octupole effective forces, a microscopic theory for two quadrupole-octupole phonon states is developed. The model of non-independent harmonic quadrupole and octupole phonons is considered. Thus, the coupling between the quadrupole and octupole harmonic phonons defined by the random phase approximation is given by the anharmonic terms appearing from the exact commutation relations between quadrupole and octupole operators. For the treatment of these terms the spectral decomposition method is used. Explicit expressions for the correction to the first 2^{+} and 3^{-} states, for the splitting of the quintet (1^{-}, 2^{-}, 3^{-}, 4^{-}, 5^{-}) and for the electromagnetic transition probabilities are obtained. The nucleus ^{114}Sn is described in detail. (auth)

19416 HIGHER ORDER DEFORMATIONS AND ELECTRIC MONOPOLE TRANSITIONS IN DEFORMED NUCLEI. Aveledo, Claude Enrique. Lawrence, Kan.; Univ. of Kansas (1971). 37p. University Microfilms Order No. 71-27,119.

Thesis.

Theoretical predictions of the ratio of E0 and E2 transitions

depopulating a 0+ excited state did not agree very well with experimental results in rare-earth nuclei. These ratios are usually designated by the letter X. In a calculation done ten years ago, the nucleus was considered to be an axially symmetric rotor model with surface oscillations. This model predicts values that are two to five times greater than experimental results. A latter calculation added to the former model a rotation vibration interaction which leads to a better agreement with experiment. In both models, the X ratio is a function of a nuclear deformation parameter which is obtained from experimental values of the quadrupole moment of the nucleus. It is pointed out that the quadrupole moment of the nucleus does not determine a unique value of the deformation parameter. It is also shown how the use of a set of three deformation parameters, previously determined by other workers from alpha scattering experiments, leads to good theoretical values for quadrupole moments, X ratios and the deformation contributions to isotopic shifts. It is further shown that the rotation vibration interaction does not influence the X ratio from the second 2+ state. The ratio of E2 transitions from a state belonging to an excited rotational band to two different states belonging to the ground state rotational band does not depend on the nuclear deformation parameters assumed. It is shown how recent experimental ratios of these E2 transitions can be well explained by a vibrating axially symmetric rotor model when rotation vibration interactions are considered as a small perturbation. (Diss. Abstr. Int., B)

19417 A COMMENT ON SHELL CORRECTIONS TO NUCLEAR BINDING ENERGIES. Bottino, A.; Ciocchetti, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Phys. Lett.; 38B: No. 3, 140-2(7 Feb 1972).

An elementary method to correct the semi-classical evaluation of nuclear masses for shell effects is presented and compared with other approaches. (auth)

19418 DISSOCIATION OF RELATIVISTIC NUCLEI IN THE NUCLEAR COULOMB FIELD. Pilkuhn, H. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Phys. Lett.; 38B: No. 3, 143-6(7 Feb 1972).

A model is proposed for the dissociation or excitation of relativistic nuclei in the Coulomb field of heavier nuclei. For small excitation energies, explicit formulas for M1, E2, E1 and C1 (Coulomb) excitation are derived. The formula for M1 and E2 excitation is that of Weizsäcker and Williams. For other multipoles, the Weizsäcker–Williams formula is reached only for $\log(E_{lab}/m) \gg 1$ (extreme-relativistic nuclei). (auth)

19419 BRUECKNER THEORY APPLIED TO A SOLVABLE MODEL. Petry, H. R.; Schuette, D. (Univ., Bonn). Phys. Lett.; 38B: No. 3, 167-8(7 Feb 1972).

Brueckner theory is applied to the solvable Lipkin model. The difficulties connected with the choice of the single particle energies are investigated.

19420 ANALYTICAL PROPERTIES OF WAVE FUNCTIONS AT LOW ENERGY. Migdal, A. B.; Perelomov, A. M.; Popov, V. S. (Inst. of Atomic Energy, Moscow. Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 4, 874-85(Oct 1971). (In Russian).

Analytical properties of the continuum wave functions $\chi_k(r)$ are investigated for the case when there is a level with energy near zero (the level may be real, virtual, or quasistationary). It is shown that at small distances, $r \ll k^{-1}$, (k is the wave vector) the wave functions became factorizable: $\chi_k(r) \simeq [\Delta(k)]^k \chi_0(r)$ while the factor $\Delta(k)$ changes sharply within the resonance width. $\Delta(k)$ is expressed in terms of the scattering amplitude at small k and is determined by the analyticity. (auth)

19421 CRITERION FOR THE SIMULTANEOUS COEXISTENCE OF SUPERCONDUCTIVITY AND MASS ASYMMETRY OF HEAVY NUCLEI IN A SIMPLE MODEL. Ohta, Kohichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 5, 1635-7(Nov 1971).

This paper complements a previous one [Ohta, Progr. Theor. Phys. (Kyoto), 45, 70(1971)], in which N valence nucleons moving to and fro between two 2Ω-degenerate valence levels were considered on the basis of the Hartree–Bogolyubov (HB) approximation. A criterion is found which guarantees the coexistence of superconductivity and mass asymmetry in heavy nuclei. It is shown that, if nuclear fission ends in a certain way, the nucleus is divided into two unequal fragments, at least in the HB approximation. (1 figure) (R.W.R.)

19422 $K^\pi = 1^+$ EXCITATION IN DEFORMED NUCLEI. Hamamoto, Ikuko Tokyo Univ. Nucl. Phys.; A177: No. 2, 484-92(1971).

The relation of the quadrupole deformation with $\nu = \pm 1$ to the rotational motion is discussed, and the intrinsic excitation modes with $K^\pi = 1^+$ are estimated. The value of the effective charge e_{eff} (E2, $\nu = \pm 1$) is evaluated in order to discuss the magnitude of Coriolis matrix elements quantitatively. (1 figure, 1 table) (auth)

19423 GROUND-STATE CORRELATIONS OF VIBRATING CLOSED-SHELL NUCLEUS DUE TO THE RESIDUAL INTERACTION. Iwasaki, Masaharu; Yamamura, Masatoshi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 5, 1440-55(Nov 1971).

The strength of ground-state correlations calculated from the RPA with the quasi-boson approximation is known to differ by a factor of two from that calculated in various other methods. This contradiction is investigated in detail in the case of closed-shell nuclei with any single multipole interaction. It is proved that the ground-state correlations calculated by the RPA with the quasi-boson approximation are correct if only collective states are included, as suggested by Rowe, in the case of negligible exchange matrix elements of the interaction. (auth)

19424 NOTE ON PAIRING VIBRATIONAL MOTION. Kuriyama, Atsushi; Hasegawa, Munetake; Tazaki, Shigeru; Okamoto, Ryoji (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 46: No. 5, 1420-39(Nov 1971).

With the aim of achieving a unified understanding of the pairing correlation for normal and superconducting systems, the ground and 1st 0^+ states (called pairing vibrational state) are studied using the two-level model with the pairing force. There exist two kinds of aspects for the classification of states with the same set of seniority $\{v_j\}$–horizontal and vertical band aspects. Sets of operators are introduced to characterize each aspect. The former (horizontal) has direct correspondence between the characteristic behavior of phase transitions, and the information from two-nucleon-transfer reactions. However, it can describe only the behavior of a phase transition, and not its mechanism. In the latter aspect it is possible to specify four types of operators, each of which plays a characteristic role in the phase transition. It is shown that this latter set of operators includes the eigenmode operators of pairing vibrational motion for the normal and super systems, that is, the two-boson operator $Y^\dagger_{pv} = X^\dagger_p X^\dagger_v$ and two-quasi-particle operators $Y^\dagger_{pv}$, in a unified manner. (8 figures) (auth)

19425 QUARTET EFFECTS IN THE NUCLEAR MASSES AND EXCITATIONS. Danos, Michel (National Bureau of Standards, Washington, D. C.); Gillet, Vincent. Z. Phys.; 249: No. 4, 294-311(1972).

The assumptions of the quartet model are given, and it is shown that they are consistent with the fine structure of the nuclear mass curves throughout the table. It is also shown by an analysis of the nuclear masses that the quarteting effect accounts for $\frac{2}{3}$ of the neutron binding energies. The consequences of the quartet picture for the existence of low-lying many-particle–many-hole states in medium and heavy nuclei are discussed. (12 figures) (auth)

19426 SENSITIVITY OF NUCLEAR MATTER BINDING ENERGY TO THE NUCLEON–NUCLEON PHASE SHIFT AT HIGH ENERGIES. Chong, K.-F.; Singh, Y.; Sprung, D. W. L. (McMaster Univ., Hamilton, Ont.). Phys. Lett.; 38B: No. 3, 132-4(7 Feb 1972).

Nuclear matter binding energy is found to depend considerably upon the phase shift at high energies, when rank two separable potentials of short range in real space are employed. Such sensitivity had not been found in earlier work which employed potentials of reasonable ranges of order 1 fm. (auth)

19427 KINEMATIC EFFECTIVE CHARGES IN PHOTONUCLEAR REACTIONS. Miller, H. G.; Arenhoevel, H. (Max-Planck-Institut fuer Chemie, Mainz). Z. Phys.; 249: No. 4, 327-31(1972).

It is shown that the Gartenhaus–Schwartz transformation of the electric multipole operator, $\Omega^{[L]}$, i.e., expressing it in lab frame coordinates, not only leads to the well-known concept of kinematic effective charges, but in addition gives 2-, 3-, ..., N-particle operator contributions, where N = min (A,L). In particular, for E2 transitions the electric quadrupole operator contains one- and two-particle operators which contribute to the single-particle transition rate and which lead to two-particle transitions. (auth)

19428 CONFIGURATION MIXING EFFECT ON THE FORM FACTOR OF ONE-NUCLEON TRANSFER REACTIONS: HARTREE–BOGOLYUBOV CALCULATION. Sugaware-Tanabe, Kazuko (Yale Univ., New Haven). Nucl. Phys.; A177: No. 2, 650-64(1971).

The formulation of the form factor of one-nucleon transfer reactions is considered; it is asymptotically correct and takes account of the configuration-mixing effect due to the pairing interaction and the collective vibrational states. Numerical calculations based on the Hartree–Bogolyubov approximation are carried out

for nickel, iron, and zirconium isotopes. The results imply that the level dependence of the self-energy and pairing potential is important; this is neglected in the usual BCS theory. The configuration-mixing effect shifts the form factor towards the inner region in the (d,p) reaction and the outer region in the (p,d) reaction. Improved fits are obtained for the angular distribution for $f_{\frac{7}{2}}$ pick-up and stripping reactions. This theory also gives directly the values of the cross section, which are in good agreement with experiment for the reaction $^{58}Ni(p,d)^{57}Ni$. (11 figures, 4 tables) (auth)

19429 FINITE-NUCLEAR-SIZE EFFECT ON THE GROSS THEORY OF FIRST-FORBIDDEN β DECAY. Takahashi, Kohji; Takeda, Harunori; Yamada, Masami (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 46: No. 5, 1637-9(Nov 1971).

The finite-nuclear-size effect on the gross theory of β decay is reinvestigated by studying typical first-forbidden operators. The effect is fairly large on one, but not on the other. (1 figure) (R.W.R.)

19430 OSAKESTE JA VALGUSE MAAILMAST. VI. TAPPISTEADUSTE SEKTSIOONI TOIMETISED. (World of Particles and Light. VI. Proceedings of the Section of Exact Sciences). Tallinn; Kirjastus Valgus (1971). 88p.

The conference included seven papers. Separate abstracts were prepared for three papers. Other papers were outside the scope of NSA. (J.F.P.)

For abstracts of individual papers see: 19034, 19431, and 19432.

19431 MUON CAPTURE AND NUCLEAR PHYSICS. Palgi, L. (Inst. of Physics and Astronomy, Tallinn). pp 19-32 of Osakeste ja Valguse Maailmast. VI. Tallinn; Kirjastus Valgus (1971). (In Estonian).

A popular survey on muon capture is given with the aim to emphasize the difficulties and advantages connected with the "nuclear barrier" in the muon capture study. (auth)

19432 BOHR THEORY WITH NUCLEAR FORCES. Lembra, J. (Tartu State Univ.). pp 33-40 of Osakeste ja Valguse Maailmast. VI. Tallinn; Kirjastus Valgus (1971). (In Estonian).

Previous work which deals with the Bohr theory for the Yukawa potential in the case of circular orbits gives rise to some general remarks allowing an analogous theory to be developed for other potentials characterizing nuclear forces. Applying Newton's second law and Bohr's postulate a formula is obtained for calculation of the total energy of two nucleons. It is found that the number of energy levels is finite and equal to the greatest integer less than n. In addition, from simple geometrical conceptions it is obvious that the levels are placed in an order in which the quantum numbers increase as the energy levels become higher. Calculations given previously can be considered as an example of the above theory. The example of the Hylleraas potential is given. Energy levels can be calculated with a given formula. While parameters characterizing the potential are poorly known, one can calculate roots of a given equation starting from the given n values and then determine energy levels in terms of the argument n/n. Results are plotted. (J.F.P.)

19433 CALCULATION OF THE ALPHA-DECAY OVERLAP INTEGRAL. Carjan, N. (Inst. of Atomic Physics, Bucharest); Sandulescu, A.; Stratan, G. Rev. Roum. Phys.; 16: No. 8, 895-8(1971).

A method not using the Talmi–Moshinsky transformation is presented for the calculation of the overlap integral for alpha decay by deducing an explicit formula for the coefficient of the transformation to the relative center-of-mass system of the four nucleons. A Cartesian basis is used. (R.W.R.)

19434 CHARGED PARTICLE STRIPPING REACTIONS RESULTING IN LOOSELY BOUND STATES OF THE FINAL NUCLEI. Dzhamalov, P. O.; Dolinskii, E. I. (Moscow State Univ.). Yadern. Fiz.; 14: No. 4, 753-63(Oct 1971). (In Russian).

A formula for the differential cross section of the charged particle stripping reaction is deduced in framework of the peripheral model with account of the Coulomb effects in one of the vertices of the Feynman pole graph. The differential cross sections of the (d, n) and (^{3}He, d) reactions calculated with this formula are compared with the experimental data. (auth)

19435 FORMULAS FOR THE RELATIVE γ-TRANSITION PROBABILITIES OF THE MOESSBAUER ISOTOPES. Barb, D.; Constantinescu, S.; Tarina, D. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 9, 1005-21(1971).

Expressions for the relative angle-dependent and also integrated γ-transition probabilities are given for the most usual Moessbauer isotopes. (9 tables) (auth)

19436 CORRELATIONS IN ALPHA-PARTICLE-ACCOMPANIED FISSION. Feather, N. (Univ. of Edinburgh). Proc. Roy. Soc. Edinburgh, Sect. A; 69: Pt. 2, 149-64(1971).

The attempt is made to exhibit the necessary correlations between fragment excitation (or prompt neutron number), fragment kinetic energy, and α-particle energy, in α-particle-accompanied ternary fission. Treating a single mode of mass and charge division on the assumption that the ternary process develops directly out of an intermediate binary phase, and using the mutual electrostatic-potential energy of the nascent binary fragments of this phase and the additional kinetic energy developed at the moment of α-particle emission as independent variables, various formal results are obtained and discussed in the light of the experimental evidence. In terms of a classical description, it appears likely that (for a given mode of division) the nuclear configuration at α-particle release in ternary fission is subject to much smaller variations than is the nuclear configuration at scission in binary fission in the corresponding mode. Possible inadequacies of this classical description are very briefly discussed. (auth)

19437 GROUP THEORETICAL APPROACH TO THE MANY NUCLEON PROBLEM. de Wet, J. A. (Univ. of South Africa, Pretoria). Proc. Cambridge Phil. Soc.; 70: 485-96(Nov 1971).

Representations of the four-dimensional unitary group U_4 were considered by Wigner (1937) as a model for nuclear isobaric multiplets. However, the Hamiltonian did not include the components of isospin which together with the spin coordinate are known to label the nuclear states. In this paper representations characterized by the eigenvalues of angular momentum J, isospin T and parity π, are found and also mass relations which give good agreement with the experimental energy levels of ^{6}Li and ^{8}Be labeled by the same quantum numbers. (auth)

19438 NON-ADIABATIC EXCITATION OF NUCLEONS IN A FISSILE SYSTEM. Gamalya, I. A.; Marshalkin, V. E.; Cherdantsev, P. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 5, 16-22(1971). (In Russian).

The probability of nonadiabatic nucleon transitions in a fissile system was examined. Nearly all excitation energy goes into the excitation of independent-particle degrees of freedom. The number of occupied nucleon states and the potential energy of collective motion were calculated for several values of the deformation parameter. (tr-auth)

19439 SINGLET DEUTERON AND TRINUCLEON-INDUCED STRIPPING REACTIONS. Lim, T. K. (Drexel Univ., Philadelphia). Nucl. Phys.; A180: No. 2, 668-72(1972).

The normalization factor for zero-range and finite-range DWBA calculations of (h,d) reactions has been determined by three theoretical methods. Although the values obtained show a fair spread, they are all, nevertheless, close to the single N(h,d) extracted from experiment. (auth)

19440 CONFIGURATION STATE AND THE $T_<^3$ TERM IN THE ISOBARIC MASS EQUATION. Auerbach, N.; Lev, A. (Tel-Aviv Univ., Israel). Nucl. Phys.; A180: No. 2, 651-6(1972).

A second-order correction to the isobaric mass equation is calculated taking into account the Coulomb mixing of the analog state with the "configuration state." The coefficient of the $T_<^3$ term is found to be of the order of 1 to 3 keV. (auth)

19441 NATURE OF EFFECTIVE INTERACTION IN THE 1f–2p SHELL. Kulkarni, D. R.; Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). Nucl. Phys.; A180: No. 2, 529-44 (1972).

The effective two-body interaction in the 1f-2p shell given by Kuo and Brown is expressed in the basis of SU_3 representations. The interaction is dominantly central in character and also contains some SU_3 breaking components. The SU_3 mixing caused by the interaction is such that it is greatly reduced when the single-particle energies have a $l(l+1)$ sequence, i.e. the 2p state is below the 1f state. This implies that the two-body interaction is also dominantly quadrupole-quadrupole type. To identify explicitly the SU_3 breaking components, the interaction is expressed in terms of radial integrals and the SU_3 symmetry properties of these radial integrals are studied. (auth)

19442 ASYMMETRIC ROTOR WITH VARIABLE MOMENT-OF-INERTIA MODEL. Abecasis, S. M. (Laboratorio de Radiaciones, Buenos Aires); Hernandez, E. S. Nucl. Phys.; A180: No. 2, 485-96(1972).

An asymmetric rotor with variable moment-of-inertia (AROVMI) model is proposed to permit the simultaneous fitting of both the ground state and γ-vibrational bands in doubly even nuclei. Only those nuclei for which these bands are well established are analyzed. The results obtained from a least-squares fitting procedure are compared with the latest available experimental data

and with those calculated with the variable moment-of-inertia (VMI) model. The theoretical analysis shows a good overall agreement with experimental data into the region spanned from the very hard rotors up to the very good vibrators. (auth)

19443 ELASTIC SCATTERING OF PIONS ON LIGHT NUCLEI. II. A STUDY IN MOMENTUM SPACE WITH KISSLINGER'S MODEL Dedonder, J. P. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A180: No. 2, 472-84(1972).

The off-energy-shell contributions to the scattering of pions by nuclei are analyzed. The effects of off-energy-shell pion-nucleon scattering on the pion-nucleus elastic scattering amplitude are then studied. (auth)

19444 STUDY OF SINGULARITIES OF NON-RELATIVISTIC FEYNMAN GRAPHS. Blokhintsev, L. D.; Safronov, A. N. (Moscow State Univ.). Nucl. Phys.; A180: No. 2, 363-75(1972).

The change in the position of the leading singularities of non-relativistic Feynman graphs with their successive complications has been investigated using the block method proposed by Rudik and Simonov. Graphs describing the interaction in the final (or initial) state of a nuclear reaction, ladder graphs consisting of identical blocks and some other four-point graphs are considered as examples. From these examples it is concluded that with increasing number of internal lines the singularities of non-relativistic four-point diagrams in the cosine of the scattering angle move away fairly rapidly from the boundary of the physical region. The singularities of two-loop three-point graphs corresponding to the virtual processes of $A \rightleftharpoons B + C$ type are also discussed. (auth)

19445 SHELL-MODEL CALCULATIONS OF FISSION DECAY WIDTHS AND PROBABILITIES IN SUPERHEAVY NUCLEI. Moretto, L. G. (Univ. of California, Berkeley). Nucl. Phys.; A180: No. 2, 337-62(1972).

The stability of excited superheavy nuclei with respect to fission is studied on the basis of realistic shell models and of the BCS Hamiltonian. A statistical approach is used to calculate the deformation probabilities of excited nuclei as well as the fission and neutron decay widths. The results of the calculations show a rapid washing out with energy of the shell effects responsible for the high fission barriers predicted in the superheavy region. The first chance fission probabilities are calculated for nuclei in the region between Z = 108 and Z = 126. Two single-particle models proposed by Nilsson and by Bolsterli et al. have been used in the calculations. The results are discussed in terms of the possible production of superheavy elements by means of standard nuclear reactions. (auth)

19446 EXCITATION OF DEFORMATION VIBRATIONS BY RADIATIONLESS MUONIC TRANSITIONS. Kanatas, G.; Davidson, J. P. (Univ. of Kansas, Lawrence). Nucl. Phys.; A180: No. 2, 638-50(1972).

An investigation is carried out for selected doubly even nuclei in the rare-earth and actinide regions for possible resonances between pairs of muonic levels of the appropriate quantum numbers and certain nuclear collective states. Such resonances can lead to the excitation of the particular nuclear state involved, and could be used as an alternate means of nuclear excitation. Electric monopole excitations were found which can result in the excitation of the nuclear 0^+ level of the β-band. The muonic states involved, however, are such that the probability of nuclear excitation may be small. An electric quadrupole resonance in ^{182}W involving the excitation of the 2^+ state of the β-band is found to be a very likely candidate. Dipole and octupole resonances were also investigated; however no possible resonances were found. Also unsuccessful was the search for quadrupole excitations of the 2^+ state in the γ-band. The matrix elements involved in the E0 and E2 resonances are calculated, the nuclear contribution being computed using the nuclear collective model of Davydov and Chaban. The probability for nuclear excitation in the E2 resonance in ^{182}W is computed. (auth)

19447 STUDY OF THE DYNAMIC CORRELATIONS IN ATOMIC NUCLEI. Jain, B. K. (Bhabha Atomic Research Centre, Trombay, India). Proc. Nucl. Phys. Solid State Phys. Symp.; 1: 74-87(1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970).

The role of dynamic nucleon-nucleon correlations in nuclear structure calculations is analyzed. The information obtained on dynamic correlations from electron scattering and photon and pion absorption is evaluated. (J.W.R.)

19448 DYNAMICAL APPROACH TO THE S-MATRIX THEORY OF NUCLEAR RESONANCES. Minelli, T. A. (Univ., Padua); Zardi, F. Nuovo Cim.; 6A: No. 4, 655-74(21 Dec 1971).

In the framework of the Lippmann–Schwinger collision theory, a general formulation of the nuclear-resonance problem is derived. The approach is based on the definition of a suitable Green's function pertaining to the complete Hamiltonian of the nuclear system and on its analytic continuation in order to include the resonant states. The results here displayed are the following. As far as the collision matrix parametrization is concerned, the method provides results which coincide with those given by the Humblet–Rosenfeld theory; on the other hand, some features which characterize the dynamical resonance theories can be evidenced in the formalism. (auth)

19449 PARITY PROJECTION IN SPHERICAL NUCLEI. Boffi, S.; Pacati, F. D. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cim.; 6A: No. 4, 465-72(21 Dec 1971).

The method of projecting a good quantum number before doing a variational calculation is applied to the problem of finding parity mixing in single-particle nuclear orbitals. The unfavorable case of spherical nuclei, such as ^4He and ^{16}O, is considered, and the non-negative results are discussed. (auth)

19450 CALCULATION OF EXCITATION ENERGIES OF FISSION FRAGMENTS USING EXPERIMENTAL KINETIC ENERGY DATA. Prakash, Satya; Manohar, S. B.; Rao, C. L.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay). J. Inorg. Nucl. Chem.; 34: No. 1, 29-38(Jan 1972).

The excitation energies of the fission fragments are calculated using experimental kinetic energy data and incorporating the effects of shells in a qualitative way. These values of excitation energies are used to obtain the variation in the number of prompt neutrons emitted as a function of fragment mass. (auth)

19451 SOFT-PION THEOREMS AND DIRECT NUCLEAR PROCESSES. Lobov, G. A.; Lmonosova, T. A. JETP Lett. (USSR) (Engl. Transl.); 14: No. 11, 421-2(5 Dec 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 11, 605-7(5 Dec 1971).

The possibility of extrapolating nuclear amplitudes with respect to the momentum transfer q^2 to a point corresponding to the mass of the physical pion and the possibility of obtaining information concerning the mechanism of direct nuclear processes by investigating reactions with emission of soft pions are discussed. A broad class of diagrams with pion emission by one of the nucleons of the nucleus was considered, and it was concluded that the validity of the extrapolation procedure in nuclear processes should be considered separately in each particular case. Diagrams with emission of pions from internal as well as external lines were considered in calculating the spectra of the soft pions. It was found that the pion spectra are not sensitive to the mechanism of direct nuclear reactions. (1 figure) (R.W.R.)

19452 NOTE ON THE ASYMPTOTIC CONDITION OF NUCLEAR-FORCE SATURATION. Demin, V. F. JETP Lett. (USSR) (Engl. Transl.); 14: No. 11, 419-21(5 Dec 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 11, 602-4(5 Dec 1971).

Binding energy curves corresponding to several nucleon–nucleon potentials are discussed. Particular attention is devoted to potentials that do not satisfy the asymptotic saturation conditions, whose asymptotic behavior with respect to A sets in far beyond the limits of the region of real nuclei, and which have a dip due to the Coulomb force. This potential should be regarded as realistic, and it is concluded that the asymptotic saturation conditions are not always an unconditional test in the search for nucleon–nucleon potentials. (1 figure) (R.W.R.)

19453 GIANT RESONANCE IN THE FERMI-LIQUID DROP MODEL. Akhiezer, I. A.; Barts, B. I.; Lazurik-El'tsufin, V. T. (Kharkov State Univ.). JETP Lett. (USSR) (Engl. Transl.); 14: No. 9, 368-71(5 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 9, 535-8(5 Nov 1971).

The Fermi-liquid model with allowance for finite nuclear size is considered, and the theory is compared with the experimental data concerning the position of the giant dipole resonance in photonuclear reactions. The nucleus is regarded as a spherical drop of a Fermi liquid, and both purely nuclear and electric forces acting between the nucleons of the nucleus are taken into account. This model describes well the position of the giant dipole resonance for a large number of nuclei. In particular, it is possible to explain why the energy of the giant dipole resonance decreases more slowly than the usual $A^{-\frac{1}{3}}$ law of liquids. The parameters that enter the theory are obtained from an analysis of data that do not pertain to the giant resonance. (1 figure) (R.W.R.)

19454 WHY DO NUCLEONS BEHAVE LIKE NUCLEONS INSIDE NUCLEI AND NOT LIKE PEAS IN A MESON SOUP. Brown, G. E. (State Univ. of New York, Stony Brook. NORDITA, Copenhagen). Comments Nucl. Particle Phys.: 5: No. 1, 6-11(Jan-Feb 1972).

Evidence is first considered as to whether nucleons do retain a substantial part of their identity, relatively unchanged by the presence of other nucleons, whilst in the nucleus. The answer to the question then, at least in so far as the smallness of many-body forces and of exchange current corrections to the beta decay are relevant, is that the nucleon momenta in the nucleus are generally small, and that even the so-called strong interactions become weak for small momenta. The lowest order three-body contribution to the binding energy in nuclear matter is first considered, and the processes from which such contributions can come are shown. The number of such processes is large, and it is convenient to collect them and express them in terms of the off-mass shell pion-nucleon scattering amplitude. The discussion is concerned only with the long range parts of the interactions (those carried by pions), and surprises may be found when considering the shorter range processes, but the author feels that reliance can be placed on the hard core in the nucleon-nucleon interaction to keep nucleons well apart, so that the short range exchange currents have only small effects. (7 references) (UK)

19455 CALCULATION OF ELECTRICAL MULTIPOLE-MOMENTS OF DEFORMED NUCLEI WITH HOMOGENEOUS CHARGE-DISTRIBUTION AND ROTATIONAL SYMMETRY. Hoenig, V.; Vetter, M. (Univ., Freiburg i. B.). Atomkernenergie; 18: No. 4, 311-15(1971). (In German).

Electrical multipole-moments are calculated for homogeneously charged nuclei of rotational symmetry and specific surfaces. For rotationally-symmetric ellipsoidal nuclei the electrical 2^{2n}-pole moment is obtained as $M_{2n} = [(6Z/(2n + 1)(2n + 3)](c^2 - a^2)^n$. For nuclei with Y_{20}-deformation (quadrupoloids) the multipole moments with lowest indices are calculated. For the rotational ellipsoid the lowest coefficients of the spherical harmonic expansion are given as functions of eccentricity. (auth)

19456 CORRELATIONS IN ALPHA-PARTICLE-ACCOMPANIED FISSION. Feather, N. (Univ. of Edinburgh). Proc. Roy. Soc. Edinburgh, Sect. A: 69: 149-64(1970-1971).

The attempt is made to exhibit the necessary correlations between fragment excitation (or prompt neutron number), fragment kinetic energy, and α-particle energy, in α-particle-accompanied ternary fission. Treating a single mode of mass and charge division on the assumption that the ternary process develops directly out of an intermediate binary phase, and using the mutual electrostatic potential energy of the nascent binary fragments of this phase and the additional kinetic energy developed at the moment of α-particle emission as independent variables, various formal results are obtained and discussed in the light of the experimental evidence. In terms of a classical description, it appears likely that (for a given mode of division) the nuclear configuration at α-particle release in ternary fission is subject to much smaller variations than is the nuclear configuration at scission in binary fission in the corresponding mode. Possible inadequacies of this classical description are very briefly discussed. (auth)

19457 3-PARTICLE PROBLEM IN QUANTUM MECHANICS. Olkhovskii, V. S. (Univ., Milan. Univ., Turin). Energ. Nucl. (Milan); 19: No. 1, 50-8(Jan 1972).

A general review is presented of the equations for the 3-body problem. Special attention is given to possibilities of numerical calculations in the continuous spectrum. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

Confinement and Heating

Refer also to abstract 19480.

19458 MEASUREMENT OF TRANSVERSE DIFFUSION IN A MICROWAVE PLASMA. Bulyginskii, D. G.; Vildzhyunas, M. I.; Poloskin, B. P.; Utochkin, B. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1285-90(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1623-39(Aug 1971).

In earlier work by the authors, a correlation analysis of the fluctuating electric field in a plasma was used to measure the turbulent diffusion coefficient $D_\perp$ in a pulsed Penning discharge in hydrogen. The same method is used here in a study of turbulent diffusion in a hydrogen plasma in a mirror device. The plasma is produced by a microwave field at the electron cyclotron frequency. (auth)

19459 ION HEATING IN HIGH-MACH-NUMBER, OBLIQUE, COLLISIONLESS SHOCK WAVES. Biskamp, D.; Welter, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Rev. Lett.; 28: No. 7, 410-13(14 Feb 1972).

A mechanism for strong ion heating in oblique, collisionless shock waves is found in numerical-simulation experiments and identified with an essentially electrostatic two-ion-beam instability excited nonlinearly by the potential oscillations accompanying the whistler precursor. (auth)

19460 LOWER HYBRID PLASMA HEATING. Pesic, S. S. (CEN, Grenoble, France). Phys. Lett.; 38A: No. 4, 283-5 (14 Feb 1972).

The propagation of plasma waves in the lower-hybrid-frequency range is investigated. (auth)

19461 CO_2 LASER HEATING OF A θ-PINCH PLASMA BY INVERSE BREMSSTRAHLUNG AND INDUCED COMPTON PROCESSES. Martineau, J.; Pepin, H. (Univ. of Quebec). J. Appl. Phys.; 43: No. 3, 917-21(Mar 1972).

The heating of a θ-pinch plasma by a pulsed CO_2 laser is considered. In addition to the inverse bremsstrahlung, the induced Compton effect is taken into account as a heating process. The influence of the pulse duration on the maximum temperature attained is studied. The results show that it is preferable to deliver the laser energy slowly. In addition, if one seeks to transfer the greatest fraction of laser energy to the plasma, the pulse shape becomes important. Tailored pulses providing an increase in the energy delivery rate when the power absorbed by bremsstrahlung diminishes will increase the contribution of the induced Compton effect to the heating. (auth)

Diagnostics

Refer also to abstract 19510.

19462 (IPP-1/122) INVESTIGATION OF COLLECTIVE DISSIPATION PROCESSES IN COLLISIONLESS SHOCK WAVES BY MEANS OF LASER SCATTERING. Steuer, K. H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Oct 1971. 61p. (In German). Dep. NTIS (U. S. Sales Only).

A 90° laser scattering experiment ($\alpha \ll 1$) established that the electrons in stationary collisionless shock waves with Mach numbers between 2 and 3 are strongly heated by nonclassical dissipation processes. The frequency and wavelength spectra of the microinstabilities causing the collisionless heating and their excitation mechanism were measured by laser forward scattering ($\theta = 2$ to 6°; $\alpha \geq 1$). The scattering intensity, which is strongly enhanced for $k < 1/D$ (D: Debye length), and the asymmetry of the scattering spectrum show that high-amplitude electron density waves (≈250 times superthermal) are excited in a preferential direction in the shock front. The direction and magnitude of the line shift of the scattered light relative to the incident laser line reveal that the current in the shock front is responsible for exciting a drift instability with the frequency $\omega = 1/3\ \omega_{pi}$ (ω_{pi} = ion plasma frequency). The light scattering from thermal ion fluctuations ($k > 1/D$) was used to measure the ion temperature in the shock front. It is found that ion acoustic instabilities, which are frequently regarded as a cause of nonclassical energy dissipation in collisionless shock waves, cannot be excited under the conditions present ($T_e \approx T_i$; $v_d \ll V_e$). Using the dispersion relation for electrostatic waves perpendicular to a magnetic field it was verified that cyclotron drift instabilities, whose growth rate, frequency, and wavelength agree to a good approximation with the measured values, occur under these conditions. (auth)

19463 MEASUREMENT OF SMALL FREQUENCY SHIFTS AND SMALL CHANGES IN Q IN A MICROWAVE CAVITY. Moskalev, I. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1299-1305(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1651-60(Aug 1971).

The minimum plasma density n and the minimum frequency of collisions of electrons with ions and neutrals ν_{ei} that can be measured with a microwave cavity are determined by the Q of the cavity. A method is proposed for measuring small frequency shifts and small changes in Q. The method is based on the analysis of the signal envelope from a cavity resonator excited by a frequency-modulated source and is capable of measuring small values of n and ν_{ei}. The minimum shift is determined by the frequency stability of the source. Standard oscillators used at centimeter and millimeter wavelengths can be used to measure shifts of the order of the bandpass of a cavity with $Q \simeq 10^5$. Experimental results are given. (auth)

19464 MULTI-PASS OPTICAL ATTENUATION MEASUREMENTS UTILIZING HOLOGRAPHIC TECHNIQUES AND OPTICAL LASER SCATTERING FOR ANALYSIS OF TRANSPARENT MEDIA. Friedrich, Otto M. Jr.; Weigl, Frederic; Dougal, Arwin A. (Univ. of Texas, Austin). Anal. Instrum.; 8: II.3.1-12(1970).

From sixteenth annual ISA analysis instrumentation symposium; Pittsburgh, Pa. (25 May 1970).

Both phase and amplitude (or intensity) distortions are introduced on optical waves propagating through transparent media. Amplitude distortions may be due to absorption, reflection, and/or scattering. Increased interaction is readily obtained by multi-passing optical waves through the media. In optical holography, the phase and the amplitude of optical waves are "recorded" on a hologram and at a later time they can be "reconstructed". Through recently developed holographic techniques, the reconstructed images of reflecting objects or of transparent objects adequately reproduce the brightness distribution of the original objects. Multi-pass attenuation data can be obtained utilizing holographic techniques to record selectively a desired pass of the optical wave's propagation through a transparent medium. Holography permits good spatial resolution and is relatively insensitive to background optical disturbances. Two major classes of optical scattering are: Rayleigh scattering by particles and Thomson scattering by free electrons. Currently, Thomson scattering is being employed to study the energetic plasmas produced in this "plasma focus" experiment. The optical source is a giant-pulsed ruby laser system producing 175 megawatts of 6943 Å light with a 17 nanosecond pulse width. (auth)

19465 AREA INFLUENCES AND FLOATING POTENTIALS IN LANGMUIR-PROBE MEASUREMENTS. Szuszczewicz, Edward P. (Goddard Space Flight Center, Greenbelt, Md.). J. Appl. Phys.; 43: No. 3, 874-9(Mar 1972).

The influence of a relatively small reference electrode in a Langmuir-probe measurement of plasma density and temperature is analyzed. The analysis employs the collisionless theory of Laframboise for spherical and cylindrical probes and, in a completely general way, includes a broad range of electron densities and temperatures as well as all possible values of ion mass and multiplicity of ionization. It is shown that a ratio α of reference-electrode area to probe area of 10^4 will guarantee no distortion of the measurement as a result of a shifting reference-electrode potential. It is further shown that the constraint on α can be relaxed by approximately two orders of magnitude when the charge-normalized ion mass m_i/Z^2 is decreased from 200 to 1 amu and the ratio of reference-electrode radius to Debye length, R_r/λ_D, is decreased from 100 to 0. An additional result of the analysis is the dependence of a probe's floating potential on its geometry and radius, as well as on the properties of the plasma. A discussion of the latter result reveals in a striking manner the significant differences between the ion-current responses of spherical and cylindrical probes. (auth)

19466 OPTICAL METHODS OF DETERMINING THE PLASMA TEMPERATURE AND CONCENTRATION OF SEED ATOMS IN COMBUSTION CHAMBERS AND MHD DUCTS. Litski, Yanush (Inst. of Nuclear Research, Swierk, Poland). Pr. Inst. Masz. Przeply.; No. 54-55, 277-84(1971). (In Russian).

Two optical methods are presented for plasma temperature measurements, i.e., a generalized method of spectral-line reversal and a method of recording the absolute saturated resonance sodium

line intensity. Plasma was generated in an oxy-acetylene combustion chamber. The influence of optical thickness of the plasma, thickness of the boundary layer, and width of the exit slit of the monochromator on the accuracy of determining the plasma temperature were examined. In order to determine the accuracy of the spectral methods of temperature measurements, the contours of the sodium-line Na_1 5890 and 5896 Å were analyzed. The concentration of seed atoms and the ratio of the boundary layer thickness to the MHD duct width was determined by comparing the computed contours with those obtained by experiments. (auth)

19467 MICROWAVE MEASUREMENTS OF PLASMA PARAMETERS IN MIDDLE PRESSURE RANGE. Zakrzeswki, Zenon; Lubanski, Mieczyslaw (Instytut Maszyn Przeplywowych, Danzig). Pr. Inst. Masz. Przeply.; No. 54-55, 249-58(1971).

The theory for microwave diagnostics of waveguide plasmas is briefly reviewed. Some measurements of plasma parameters in electric discharges in argon at medium pressures are described. The dependence of the plasma parameters as a function of discharge current is discussed. (M.O.W.)

19468 EFFECT OF A MAGNETIC FIELD ON THE FLOATING DOUBLE-PROBE METHOD. Sato, M. (Yamagata Univ., Yonezawa, Japan). J. Phys., D (London); 5: No. 1, 151-4(Jan 1972).

Effects of a magnetic field on the double-probe technique are studied experimentally by means of asymmetric double probes in a low-pressure, high-density plasma. It is found that the magnetic field can considerably affect ion probe currents, even if the ion gyro radius is very much larger than the probe size; for example, by a factor of seventy for transverse current collections. At strong fields, the effective collecting area for parallel current collections becomes proportional to something like the periphery of the probe. (auth)

19469 METHOD FOR CALIBRATING HELMHOLTZ–GAUGAIN COIL DEVICE USING THE CYCLOTRON RESONANCE OF THE FREE PLASMA ELECTRONS. Gherbanovschi, N. (Univ., Bucharest). Stud. Cercet. Fiz.; 22: No. 4, 459-66(1970). (In Rumanian).

A Helmholtz–Gaugain coil device is calibrated, $B = f(I_B)$, using the cyclotron resonance of the free electrons from a hot electrode discharge in a tube under 10^{-4} to 10^{-3} torr. The parameters and discharge conditions permitting determination of the free electron cyclotron resonance $\omega = \omega_B$ from the cold plasma in a weakly ionized air system are given. (auth)

19470 MEASUREMENT OF THE ELECTRON TEMPERATURE IN A LOW-DENSITY PLASMA BY RADIOFREQUENCY PROBE METHOD. Aihara, S.; Lampis, G. (Nagoya Univ., Japan). Lett. Nuovo Cim.; 2: No. 25, 1309-13(18 Dec 1971).

The measurements were performed in a back-diffusion-type mercury plasma. The floating potential is measured by a dc voltmeter of very high impedance. The output of the oscillator is also connected to the probe. Diagrams are given of the change of floating potential as a function of the rf potential. (M.O.W.)

Kinetics (General)

19471 (CONF-710222–(Absts.)) 8th AINSE PLASMA PHYSICS CONFERENCE, 1971, 15–17th FEBRUARY 1971 AT LUCAS HEIGHTS, N. S. W. AND UNIVERSITY OF SYDNEY. Abstracts of Papers. (Australian Inst. of Nuclear Science and Engineering, Lucas Heights). 50p.

Abstracts of 50 papers dealing with various aspects of plasma physics are presented. Topics include: waves, lasers, discharge physics, high-temperature plasmas, transport and collision phenomena, shocks, and plasma theory. (Australia)

19472 (NASA-SP-236) RESEARCH ON URANIUM PLASMAS AND THEIR TECHNOLOGICAL APPLICATIONS. Proceedings of a Symposium Held January 7-8, 1970 in Gainesville, Florida. Thom, Karlheinz; Schneider, Richard T. (eds.) (National Aeronautics and Space Administration, Washington, D. C.). 1971. 436p. (CONF-700123). GPO $3.75.

Separate abstracts were prepared for the 43 included papers. (M.O.W.)

For abstracts of individual papers see: 17654, 17655, 18306, 18713, 19477–19483, 19496–19499, 19734, 19828–19852, 19858, and 19861.

Kinetics (Experimental)

Refer also to abstract 18579.

19473 (UCLA-34-P-157-X1) TASK II: PLASMA CONTROL. Progress Report, April 1, 1971–October 1, 1971. Chen, Francis F. (California Univ., Los Angeles). Contract AT(04-3)-34. 6p. Dep. NTIS.

Research developments are reported on the five following pieces of equipment; (1) high-current arc, (2) dc HCN laser, (3) pulsed HCN laser, (4) Co_2 lasers, and (5) large arcs. The status and preliminary results from each are discussed. (M.O.W.)

19474 INTERACTION OF A 30-MW ELECTRON BEAM WITH A PLASMA. Iremashvili, D. V.; Kuril'nikov, S. V.; Leont'ev, N. I.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1278-80(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1624-6(Aug 1971).

The experimental investigation of the interaction of a 3-kA electron beam produced by a spark source with plasma which enters the interaction chamber from the source is reported. It is shown that intense longitudinal high-frequency oscillations are excited in the frequency range 800 to 7000 MHz. The oscillations are most effectively excited in the absence of a magnetic field. The estimated total power of the oscillations over the whole frequency spectrum is 300 kW, corresponding to 1% of the beam power. It is proposed that the efficiency of the interaction in the beam–plasma system can be considerably higher. (auth)

19475 MICROWAVE RADIATION FROM A COLLISIONLESS CESIUM DISCHARGE. Karakhanov, V. Ya.; Kucherov, R. Ya.; Kashirskii, E. A.; Oganezov, Z. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1383-5(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1752-5(Aug 1971).

The relation between the frequency spectra and the intensity of the microwave radiation and the plasma parameters in a Knudsen discharge in cesium is investigated over a wide range of plasma densities. It is shown that the frequency of the microwave radiation corresponds to the plasma frequency. (auth)

19476 DETERMINATION OF THE GYROMAGNETIC CONDUCTIVITY OF SLIGHTLY IONIZED AIR DURING A HOT-CATHODE DISCHARGE. Gherbanovschi, N. (Univ., Bucharest). Rev. Roum. Phys.; 16: No. 10, 1127-35(1971). (In French).

An experimental device for the study of the conductivity variation of slightly ionized air immersed in a magnetic field is described. The theory and interpretation of the experimental results are given. The parametric conditions necessary to ascertain the cyclotron resonance, $\omega = \omega_c$, of the free electrons in the discharge plasma are described. The pressure interval is indicated within which the absorption maximum corresponds to the critical frequency $|\omega - \omega_c| \neq 0$. (auth)

19477 SPECTROSCOPIC STUDY OF A URANIUM ARC PLASMA. Campbell, H. D. (Univ. of Florida); Schneider, R. T.; Kylstra, C. D.; Randol III, A. G. pp 187-95 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Measurements of temperatures, particle densities, emission, and absorption coefficients of a uranium arc are reported. The motivation for the research was to acquire fundamental knowledge of the physical properties of uranium plasmas which will, in turn, eventually lead to the design of a self-sustaining fissioning plasma. The arc is generated in a high-pressure cell capable of withstanding pressure up to 100 atm. The current passes between a tungsten-pin cathode and a uranium-pellet anode. A cover gas of helium is used and substantial vaporization of uranium takes place as the pellet temperature rises and the arc stabilizes. The atomic characteristics of the helium and uranium are such that the emitted line radiation originates primarily from singly ionized uranium. Spectroscopic diagnostics were used throughout the investigation. Several methods of temperature determination were employed, including Boltzmann plots, relative line intensities, and brightness emissivity methods. Although there are difficulties associated with each method, all temperature measurements were found to lie in the range of 7,500 to 12,000 K. The measurements of emission and absorption coefficients of the plasma were taken over the pressure range of 3 to 15 atm and current range of approximately 15 to 10 A. The corresponding partial pressure of uranium over the range was estimated to be 0.1 to 0.5 atm. (auth) (STAR)

19478 URANIUM PLASMA OPACITY MEASUREMENTS. Miller, M. H.; Wilkerson, T. D.; Koopman, D. W. (Univ. of Maryland). pp 197-204 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Absolute opacities of uranium plasma (2800 to 8800 Å) were measured by a gas-driven shock tube. Temperatures (7,500 to 12,000 K) and partial pressures (1/50 to 1/5 atm) approach those anticipated at the hydrogen/uranium interface of proposed gaseous-core nuclear reactors. At these conditions, uranium (U I, U II, and U III) is essentially the only spectroscopically active constituent of shock-tube test gases composed to 0.2 to 2.0% UF_6 in neon. Absolute opacities at 5000 Å are measured photoelectrically, both in emission and in absorption. Time-resolved photographic recording was used to determine the variation of opacity with wavelength. Visible opacities are two to five times smaller than those of theoretical predictions, the variance depending on the plasma state. The relative contribution to the opacity from the continuum appears to be tenfold greater than that predicted. The variation of opacity with wavelength was found to fit theory well between 4000 and 8800 Å, but observed opacities decreased rapidly in the uv range, whereas theory predicts that they should increase strongly. (auth) (STAR)

19479 GENERATION OF A FISSIONING PLASMA. Kylstra, C. D.; Schneider, R. T. (Univ. of Florida). pp 205-9 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Measurements of the radiation emission properties of a uranium plasma were made on thermally excited plasmas. Attempts were also made to determine what fraction of fission energy is emitted from the plasma as nonequilibrium radiation, as compared with the amount of fission energy deposited by heating up the plasma, and what the spectrum of the nonequilibrium radiation is. The instruments used and the problems associated with such measurements are also discussed. (STAR)

19480 INVESTIGATION OF ARC PLASMA AT EXTREMELY HIGH PRESSURES. Bauder, Uwe H.; Soehngen, Erich E. (Aerospace Research Labs., Wright-Patterson AFB). pp 211-15 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Some aspects of the high-pressure plasma research program are described. This program is concerned with studies of electric arc discharges in selected gases at pressure levels up to 1000 atm. Under the initial phase, transport properties of argon at pressures up to 150 atm are being determined. The method involves measurements of the integral arc parameters and the radial temperature distribution, from which the electrical and thermal conductivities as well as the radiation source strength of the plasma may be determined as a function of temperature and pressure. The test facility and the measurement technique are described, and first results obtained with argon are presented. Extension of the method to measurements in gas mixtures containing uranium vapor appears feasible. (auth) (STAR)

19481 KINETIC STUDIES OF NUCLEAR-SEEDED MHD PLASMAS. Ellis, W. H. (Univ. of Florida); Imani, K.; Cofer, H. G. pp 327-34 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

A method for studying the electron kinetics in plasmas produced by neutron irradiation of nuclear-seeded noble gases is described. Experimentally determined production and loss parameters for plasmas produced by the slowing down of the reaction products of the $^3He(n,p)t$ reaction are reported for a range of helium gas pressures (1 to 10 atm) of interest for reactor coolant and MHD conversion applications. The voltage-output signal amplitude of the pulsed ionization chamber (PIC) is used to measure the steady-state electron density as a function of reactor power and the measured ionization source rate (ion pairs/sec) for plasmas produced within the ^3He gas filling of the ion chamber during neutron irradiation in the reactor thermal column. Plasma loss coefficients can then be determined directly and the mechanisms of production and loss studied. Values reported for the second-order plasma loss coefficients obtained with electron densities measured by the PIC technique for steady-state helium plasmas as a function of pressure were in excellent agreement with theoretical predictions. (auth) (STAR)

19482 GAS LASER PUMPING VIA NUCLEAR RADIATIONS. Guyot, J. C.; Miley, G. H.; Verdeyen, J. T.; Ganley, T. (Univ. of Illinois). pp 357-68 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Research studies indicate that direct nuclear radiation pumping of certain gas lasers is feasible in the high fluxes provided by a pulsed nuclear reactor. It is further demonstrated that there are significant differences between nuclear radiation pumping and normal electrical excitation. Basic optical absorption and electron density–temperature measurements were undertaken for capitalizing on these differences and obtaining a clear understanding of the mechanisms involved. (STAR)

19483 ENHANCEMENT OF LASER OUTPUT BY NUCLEAR REACTIONS. Allario, F. (NASA Langley Research Center); Schneider, R. T.; Lucht, R. A.; Hess, R. V. pp 397-400 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The effect of nuclear reaction products (including light and heavy particle and gamma rays) on the population inversion of gas lasers is considered, with emphasis on molecular and ionic systems. Preliminary experimental results are presented on the enhancement of the output power of CO_2 laser excited by an electric discharge and irradiated by neutrons obtained from a nuclear reactor. The use of high-energy particles introduces an additional source of ionization and offers a possibility for operation of laser tubes with larger volumes and higher pressures. (STAR)

19484 INFLUENCE OF ASSUMED VALUES OF ELASTIC COLLISION CROSS SECTIONS IN LOW-TEMPERATURE PLASMA ON PARAMETERS OF ELECTRIC CONDUCTIVITY. Kordus, Aleksander (Instytut Nowych Zrodel Energii Politechniki, Poznan, Poland). Pr. Inst. Masz. Przeply.; No. 54-55, 59-68(1971). (In German).

The dependence of calculative results of parameters σ_0, σ_1, and σ_2 on the assumed values of electron elastic collision cross sections with neutral and charged particles is presented. The comparison is carried out assuming: independence of the frequency of collisions of velocity of electrons; change in impact frequency within the range of energy of electrons 0.05 to 1 eV after Frost's approximation; and change in impact frequency within three ranges (0.01 to 0.1, 0.1 to 1, and 1 to 5 eV) after EDF approximation. The calculation method, algorithm, and results for the plasma of combustion products with seeding are given. (auth)

19485 EXPERIMENTAL INVESTIGATIONS IN A SUPERSONIC MAGNETOPLASMADYNAMIC RING CHANNEL. Rothhardt, Ludwig; Jahn, Guenter (Zentralinstitut fuer Elektronenphysik, Jena, Ger.). Pr. Inst. Masz. Przeply.; No. 54-55, 31-46 (1971). (In German).

The construction of the complete experimental device is described. The device, consisting of an induction–hydrodynamic plasma source with a working tube attached, may be utilized as an electromagnetic shock tube (filled with gas at constant pressure) or as a plasma gun (with pulse gas filling). The interaction between the plasma flowing in the ring channel and the magnetic field generated with the use of the air solenoid embracing the channel is studied. More essential properties of the current are also described. In conclusion, further problems that could be examined with the use of the above apparatus are indicated. (auth)

19486 MAGNETOPLASMADYNAMIC EXPERIMENTS IN COMPOSED ELECTROMAGNETIC SHOCK TUBES. Rothhardt, Ludwig (Zentralinstitut fuer Elektronenphysik, Jena, Ger.). Pr. Inst. Masz. Przeply.; No. 54-55, 23-30(1971). (In German).

Experiments were carried out with a plasma produced in an induction-hydrodynamic shock tube, then introduced into a rail plasma accelerator and accelerated in the direction opposite to the flow. The phenomenon is discussed on the basis of photographs taken with the use of a drum-type camera, and relative temperature measurements. In conclusion, a short critical review of Polish and Soviet works on the phenomenon of the so-called "T-layer" is given. (auth)

19487 ELECTRON-IMPACT EXCITATION OF THE 0–0 BAND, N_2^+ 3914 A. McLean, E. A.; Ali, A. W.; Stamper, J. A.; Dean, S. O. (National Research Lab., Washington, D. C.). Phys. Lett.; 38A: No. 3, 209-10(31 Jan 1972).

The electron impact excitation rate coefficient of N_2^+ 3914 Å from the ion ground state measured at T_e = 3.8 eV was found to be much smaller than the value inferred from a measured cross section. (auth)

19488 CONTRACTION MECHANISM IN A DIFFUSION-CONTROLLED POSITIVE-COLUMN PLASMA. Toader, Emil I. (Univ., Bucharest). Rev. Roum. Phys.; 16: No. 8, 827-33 (1971).

A self-contraction mechanism of a positive-column plasma in the range of medium pressures is reported. A cylindrical, long plasma column obtained in an inert gas discharge was studied. It is shown that for pressures higher than 10 torr the diffusion loss is smaller than the recombination loss. (auth)

19489 LOW-PRESSURE TOROIDAL GLOW DISCHARGE IN A RADIAL MAGNETIC FIELD. Pekarek, St. (Technical Univ., Prague). Phys. Lett.; 38A: No. 3, 175-6(31 Jan 1972).

By measuring the force acting on a flag suspended in a plasma flow, the plasma velocity was estimated. For the case when $\eta \gg \sigma B_z^2$, Kracík's theory was verified experimentally. (auth)

19490 NONLINEAR INTERACTION OF AN ELECTRON BEAM WITH A PLASMA. Gabovich, M. D.; Kovalenko, V. P. (Inst. of Physics, Kiev). Dokl. Akad. Nauk SSSR; 199: No. 4, 799-801(1 Aug 1971). (In Russian).

The interaction of previously modulated and unmodulated electron beams with a plasma generated by them was studied in an argon pressure from 10^{-3} to 10^{-2} mm Hg. At some distance from the cathode, in the electron beam, a scatter zone ("meniscus") was sharply defined, in which was located an amplitude maximum for higher harmonic oscillations. With a beam energy of 1.5 keV and current of 60 mA, meniscus was clearly observed in both modulated and unmodulated beams. (K.S.W.)

Kinetics (Theoretical)

19491 (MATT-816) TOROIDAL EQUILIBRIUM OF A RELATIVISTIC ELECTRON RING. Yoshikawa, S. (Princeton Univ., N. J. Plasma Physics Lab.). Jan 1972. Contract AT(30-1)-1238. 5p. Dep. NTIS.

A relativistic electron beam possibly could be used to provide a current-carrying ring in a toroidal confinement system. The equilibrium relations for this relativistic ring are presented. (auth)

19492 (SC-T-722456) INJECTION OF A RELATIVISTIC ELECTRON BEAM INTO A PLASMA. Rosinskii, S. E.; Rukhadze, A. A. Translated by Patricia Newman (Sandia Labs., Albuquerque, N. Mex.), from Conference on Plasma Theory, Kiev, USSR, October 19–23, 1971. 19p. (CONF-711016-7). Dep. NTIS.

The fields and currents induced in a dense plasma due to the injection of a relativistic electron beam are investigated. It is shown that, during a time less than the collision time of the plasma electrons, the induced fields and currents represent a superposition of fields and currents accompanying the beam (static in the rest system of the beam) and transition fields and currents essentially caused by the very beginning of the injection process and vanishing in the course of a time greater than the collision time of the electrons. The nature and magnitude of this transition radiation are evaluated. It is shown, in particular, that transition fields are almost potential in nature; the magnetic field is small in comparison with the electric field. The problem is solved in two formulations: (1) injection of a beam with finite time τ, and (2) injection of a beam with a finite interval of space between points z = 0 and z = l_0. (auth)

19493 DERIVATION OF EQUATIONS FOR ROTATIONALLY SYMMETRIC, STATIC, INCOMPRESSIBLE PLASMAS WITH INFINITE CONDUCTIVITY AND THEIR BOUNDARY-VALUE PROBLEM. Schaefer, D. (Univ., Bonn). Beitr. Plasmaphys.; 11: No. 4, 359-64(1971). (In German).

The equations of a rotationally symmetric, static, incompressible plasma with infinite conductivity are equivalent to an elliptic differential equation for the function $\xi = -4\pi(p + \rho\Phi)$ where p means the pressure, ρ the density, and Φ the potential of the external forces. Moreover, this differential equality contains two arbitrary functions of ξ. When $\xi_p^2 + \xi_z^2 > 0$, both arbitrary functions can be computed from the boundary values of H_φ and $H_\perp$ (the component of H, which is perpendicular to the boundary). (auth)

19494 EFFECT OF AN EXTERNAL CIRCUIT ON ANOMALOUS RESISTIVITY IN PLASMAS. Nishihara, Katsunobu; Hasegawa, Akira (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 28: No. 7, 424-7(14 Feb 1972).

A large-amplitude electron plasma oscillation, which is excited in a plasma as a result of its coupling to an external circuit, decays into ion modes and excites low-frequency fluctuations. Such a process is shown to contribute to dc anomalous resistivity. (auth)

19495 ELECTRON BEAMS AND LANDAU DAMPING. Beck, A. H. (Cambridge Univ., Eng.). pp 18,1-6 of MOGA 70. Deventer, Netherlands; N.V. Uitgeversmaatschappij Kluwer (1970).

From eighth international conference on microwave and optical generation and amplification; Amsterdam, Netherlands (7 Sep 1970). See CONF-700914.

The power exchange between an electron beam and a traveling wave was investigated. Space-charge calculations are made and it is shown that strong absorption occurs when the phase velocity is above the electronic velocity. It is also shown that a self-consistent power calculation yields a minimum of three forward waves. (M.O.W.)

19496 FEASIBILITY OF A NUCLEAR LASER EXCITED BY FISSION FRAGMENTS PRODUCED IN A PULSED NUCLEAR REACTOR. Russell, G. R. (Jet Propulsion Lab.). pp 53-62 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The role that high-energy particles play in the direct excitation of laser excited states is emphasized. An analysis is presented in which the effects of low-energy thermal electrons and high-energy particles are included simultaneously in determining the population of the excited states of atomic argon irradiated by fission fragments. (auth) (STAR)

19497 CONDITIONS FOR LOCAL THERMODYNAMIC EQUILIBRIUM IN URANIUM. Delmer, T. N.; Vulliet, W. G. (Gulf General Atomic, Inc.). pp 173-8 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Possible effects on uranium opacities due to populations of bound states not in local thermodynamic equilibrium (LTE) are investigated. The simple model used to calculate the pertinent atomic parameters is described. Although the model is capable of giving only qualitative results, it gives estimates of situations in which a uranium plasma will show deviations from thermodynamic equilibrium. Temperatures and densities at which these deviations become significant are given. Some cases in which non-LTE effects are important are discussed in detail, and the LTE values of the opacity and source function are compared with the correct values. (auth) (STAR)

19498 EFFECTS OF COLUMNAR RECOMBINATION ON CONDUCTIVITIES OF NUCLEAR-SEEDED PLASMAS. Orvis, D. D.; Dalton, G. R. (Univ. of Florida). pp 351-4 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The nonlinear effects of recombination and collective diffusion associated with nuclear-seeded ionization are investigated. There was very little collective diffusion and practically no recombination above that expected for a homogeneous plasma for the ionization of ^{3}He in a nuclear reactor by the (n,p) reaction. However, high pressures in the range of 20 to 100 atm increase the recombination modestly. The strong influence comes from an increase in temperature, ionization track density (as experienced with fission fragments), and recombination coefficient. It is speculated that there may be significant decreases in the charge available to uranium systems due to columnar effects. This is viewed as an increase in the effective value for the fission fragments in the gas. (STAR)

19499 CALCULATIONS OF IONIZATION–EXCITATION SOURCE RATES IN GASEOUS MEDIA IRRADIATED BY FISSION FRAGMENTS AND ALPHA PARTICLES. Thiess, P. E.; Miley, G. H. (Univ. of Illinois). pp 369-96 of Research on Uranium

Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The problem of predicting the spatial distribution of primary ionization–excitation source rates in a fluid being irradiated by ions from an adjoining solid fuel layer is considered. The slowing and charge loss law is used along with a transmission function previously developed to predict the energy spectra of the flux of charged particles at any plane in the fluid slab. Excitation cross sections for direct impact and secondary effects due to high-energy secondary electrons (delta rays) and recoil atoms are surveyed. A delta-ray recoil atom pseudo cross section is derived to include these secondary effects in the calculations. The flux spectra and cross sections are used to compute the spatial variation in the production rate of ionization or excitation. Detailed results are presented for the irradiation of helium in a channel bounded by fuel plates on either side. In addition to the spatial variation in the source rate of excited states produced, the total excitation produced in the channel is obtained, as well as its variation with gas pressure for the case of low gas pressures. (auth) (STAR)

19500 WIEDEMANN–FRANZ LAW FOR A HIGH-FREQUENCY, FULLY IONIZED PLASMA. Lupu, Gheorghe (Univ., Cluj). Rev. Roum. Phys.; 16: No. 10, 1187-93(1971).

The Wiedmann–Franz law fails for a high-frequency, fully ionized plasma. Thus, in this case, $\lambda/\sigma T_e \approx RT_e^{-5}$. The proportionality coefficient R depends on the electric field E and on the collision frequency ν_1. (auth)

19501 GENERALIZED FLUX CONSERVATION FOR PLASMAS. Buckingham, M. J.; Byrne, J. C.; Burman, R. R. (Univ. of Western Australia, Nedlands). Phys. Lett.; 38A: No. 4, 233-4(14 Feb 1972).

A generalized flux conservation theorem is obtained for multi-fluid plasma with relativistic currents, inertial effects being included. (auth)

19502 SCATTERING CROSS SECTION OF SLOW NEUTRONS IN MAGNETICALLY CONFINED PLASMAS. Weil, Juergen W. (Univ., Innsbruck). Acta Phys. Austr.; 33: No. 1, 71-9(1971). (In German).

An attempt is made to establish a relation between the motion equations for the ions of a plasma confined in a magnetic field and the double differential scattering cross section for the multiple scattering of slow neutrons. The Sunakawa scattering formula is derived. The scattering of slow neutrons on a magnetically confined Cs plasma was examined. The magnetic field is assumed to be homogeneous and the plasma has electrostatic ion oscillations in the x plane. The double-differential effective cross section derived fulfills the principle of detailed balance. The evolving delta functions cause a type of quantization. (J.S.R.)

19503 EVALUATION OF BOLTZMANN INTEGRALS FOR INELASTIC COLLISION AND RADIATIVE PROCESSES IN MONATOMIC PLASMAS. Claassen, H. A. (Institut fuer Technische Physik, Juelich, Ger.). Z. Naturforsch.; 26a: No. 11, 1888-96(Nov 1971).

Within the scope of a moment method, collision integrals of the Boltzmann type are formulated and evaluated for the different excited particle states of a stationary monatomic plasma macroscopically at rest. All collision and radiative processes except the three-body recombination are considered. The calculations are performed within Grad's 8-moment approximation of the momentum distribution functions of the material particle components. Assuming axial symmetry of the differential collision cross sections, the evaluation leads to linear functions of generalized Chapman–Cowling integrals for binary inelastic particle interactions and to Einstein and photoionization coefficients for the radiative processes. Simplifications are given in special and limiting cases. (auth)

19504 LIMIT CONDITIONS IN A FLOW OF GAS WITH HEAT ADDITION AND IONIZATION. Smigielski, Jozef (Instytut Maszyn Przeplywowych, Danzig). Pr. Inst. Masz. Przeply.; No. 54-55, 179-89(1971). (In German).

The flow of a monoatomic gas with heat addition and ionization in a channel with a constant cross sectional area was analyzed. As a result, the relations determining the dependence of the maximum temperature and temperature corresponding to the maximum heat added (maximum entropy) upon the gas flow for the given pressure and channel diameter were obtained. Detail calculations were carried out for the gas flow V ranging from 3 to 50 litres/min for the channel diameter d = 3 to 6 mm and pressure p = 0.5 and 1 atm. abs. The results are depicted in the form of graphs. They present, for two boundary values of the Mach number, the dependence of the temperature and heat added on the gas flow, the other factors (nozzle diameter and outlet pressure) being considered as parameters. (auth)

19505 CHARGED PARTICLES IN BIANISOTROPIC MEDIA. Kong, J. A. (Massachusetts Inst. of Tech., Cambridge). Radio Sci.; 6: No. 11, 1015-19(Nov 1971).

Both electric and magnetic fields are shown to be present for charged particles at rest in bi-anisotropic media. A bi-anisotropic medium can be realized by a moving medium, a Tellegen medium, or a magneto-electric medium. The coexistence of both fields may lead to radiation of energy for certain kinds of constitutive parameters that specify the properties of the medium. Electromagnetic-field solutions of a charged particle in a Tellegen medium and a uniformly moving uniaxial medium are calculated. Physical implications of the various results are discussed. (auth)

19506 DRIFT STATIONARY SOLUTIONS IN THE THEORY OF WEAK TURBULENCE. Kats, A. B.; Kontorovich, V. M. (Inst. of Radiophysics and Electronics, Kiev). JETP Lett. (USSR) (Engl. Transl.); 14: No. 6, 265-7(20 Sep 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 6, 392-5(20 Sep 1971).

The existence of solutions of the drift type, which cause the collision integral to vanish, is shown. The case of four-particle interactions (for a nondecaying spectrum) is considered. The case for three-particle processes (in the case of a decay spectrum) is also considered. The drift solutions corresponding to known stationary distributions are listed in a table. (M.O.W.)

19507 STABILITY OF A PLANE MULTIPLE-LENS TUBE ACCELERATOR. Volkov, T. F. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1150-4(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1462-8(Jul 1971).

The stability of motion is examined for two cases: ideal model of the accelerator, and with a perturbing magnetic field. It is shown that the motion of the particles in a plane model is essentially stable. (auth)

19508 GRAD'S SOLUTION OF THE BOLTZMANN EQUATION IN TERMS OF IRREDUCIBLE SPHERICAL TENSORS AND TALMI COEFFICIENTS. Midha, J. M.; Gupta, S. C. (Punjabi Univ., Patiala, India). Nuovo Cim.; 7B: No. 2, 185-94(11 Feb 1972).

The algebra associated with Grad's method of solving the Boltzmann equation was simplified by expanding the distribution function into a polynomial based on spherical polar co-ordinates and using the Talmi coefficients for the collision part. This simplified reformulation was applied for calculating the components of the stress tensor for a fully ionized plasma in a strong magnetic field from both the Vlasov and the simplified Boltzmann equations. (auth)

19509 ELECTRIC CONDUCTIVITY OF PLASMA IN THE PRESENCE OF IMPURITIES. Lupu, Gh. (Univ., Cluj). Stud. Cercet. Fiz.; 23: No. 8, 999-1002(1971). (In Rumanian).

The electrical conductivity in a solid, when both phonon and impurity scattering are important, is studied. Using the mathematical method presented by Frisch and Lebowitz, it is shown that, in the presence of the electromagnetic field, the addition of impurities will always decrease the conductivity. (auth)

Production

19510 (NCWTD-CNDST-BIB-3) USES OF LASERS IN PLASMA PHYSICS, A Select Bibliography for the Period 1965–1970, 582 Entries. Piron, Jacques (comp.) (Centre National de Documentation Scientifique et Technique, Brussels (Belgium)). Aug 1971. 136p. Dep. NTIS (U. S. Sales Only).

This bibliography covers the period 1965 to 1970 and contains 582 references. (M.O.W.)

19511 INTENSE DISCHARGE IN AN OPEN CHANNEL WITH EVAPORATING WALLS. Golubev, E. M.; Demidov, M. I.; Ogurtsova, N. N.; Podmoshenskii, I. V.; Rogovtsev, P. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1381-2(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1750-2(Aug 1971).

A study was made of radiative and electric characteristics as well as the mechanics of channel development of an intense, pulsed discharge in large-diameter (40 to 70 mm) fibrous and polyformaldehyde tubes 200 mm long that operate with evaporating walls. Photographs of the discharge channel are described. (M.O.W.)

19512 INVESTIGATION OF THE EARLY PHASES OF PLASMA PRODUCTION BY LASER IRRADIATION OF PLANE SOLID TARGETS. Stumpfel, C. R. (Army Ballistic Research Labs., Aberdeen Proving Ground, Md.); Robitaille, J. L.; Kunze, H.-J. J. Appl. Phys.; 43: No. 3, 902-7(Mar 1972).

The time development of line radiation emitted from a plasma produced by focusing a Q-switched ruby laser onto a solid magnesium target was investigated in the vacuum-ultraviolet wavelength region using a 2-m grazing incidence monochromator. The electron temperature was obtained using the foil-absorption method. The time of appearance of Mg IX and Mg X lines at the target was measured as a function of the laser power. For the lowest laser power at which both ionic lines appeared, Mg IX radiated before Mg X. The appearance time of each line decreased as laser power was increased until at the higher powers they appeared at about the same time—2 nsec after the beginning of the laser pulse. The ionization processes occurring in front of the target are discussed using a simple model for the plasma. From the time of appearance of the lines, conclusions on the electron-temperature in the "heating zone" can be drawn as well as on an overall heating rate. (auth)

19513 TEMPERATURE LAWS FOR LASER-CREATED PLASMAS FROM THIN TARGETS. Bonnier, A.; Martineau, J. (Univ. of Quebec, Varennes). Phys. Lett.; 38A: No. 3, 199-200 (31 Jan 1972).

Using a theoretical model based on the hydrodynamic equations, a change is shown in the scaling laws for the electron temperature, T, in laser-created plasmas. The temperature laws vary from $T \propto \phi_A$ (maximum absorbed flux) to $T \propto \phi_A^{\frac{1}{3}}$ with increasing maximum incident flux ϕ. (auth)

19514 PLASMA PRODUCED BY IRRADIATION OF THIN FOILS OF ALUMINUM BY A CO_2 TEA LASER. Pepin, H.; Dick, K.; Martineau, J.; Parbhakar, K. (Univ. of Quebec, Varennes). Phys. Lett.; 38A: No. 3, 203-4(31 Jan 1972).

Preliminary investigations are reported on the characteristics of the laser-produced plasma by irradiating thin aluminum targets with a 30-MW TEA CO_2 laser. An electron density as high as $10^{18}/cm^3$ was observed. (auth)

19515 PLASMA FORMATION BY ULTRASHORT LASER PULSES. Basov, N. G.; Zakharov, S. D.; Krokhin, O. N.; (and others). Kvantovaya Elektron.; No. 1, 4-28(1971). (In Russian).

High-temperature heating of plasma by means of focusing short-duration laser radiation on a deuterated lithium surface was studied. Shadow photography of the plasma was accomplished with ultrashort pulsed illumination, and dispersion was recorded with the aid of an electron-optical converter. The time dependence of reflection of laser pulses was investigated, and the plasma electron temperature was measured by its x radiation. Basic processes that accompany the plasma heating by ultrashort pulses are theoretically analyzed, using approximations based on experimental results. (tr-auth)

Stability

19516 (CONF-710929-7) DYNAMIC STABILIZATION OF TRANSVERSE KELVIN–HELMHOLTZ INSTABILITY. Lee, Y. C.; Chu, T. K. (Princeton Univ., N. J. Plasma Physics Lab.). [1971]. Contract AT(30-1)-1238, 6p. Dep. NTIS.

From 3. international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The transverse Kelvin–Helmholtz instability is driven by nonuniform E × B motion of a plasma. An ac electric field near the ion cyclotron frequency, applied across the shear layer resulting from the nonuniform dc electric field, can be used to stabilize the transverse Kelvin–Helmholtz instability. The stabilizing effect is shown to arise from high-frequency excursion of ions near the shear layer. (auth)

19517 INSTABILITY OF A FINITE-PRESSURE, COLLISION-DOMINATED PLASMA. Tsypin, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1377-8(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1747-8(Aug 1971).

The stability of a finite-pressure, inhomogeneous, isothermal plasma is investigated in the case in which the characteristic ion and electron temperature relaxation rates ν_{ie} are much greater than the drift frequency ω_n. In contrast with earlier results indicating stabilization of the drift instability in an inhomogeneous plasma with finite pressure and uniform temperature, a collision-dominated plasma is unstable for arbitrary pressures (with uniform temperature). (auth)

19518 SATURATION OF THE DECAY INSTABILITY FOR COMPARABLE ELECTRONIC AND ION TEMPERATURES. Valeo, E.; Oberman, C.; Perkins, F. W. (Princeton Univ., N. J.). Contracts AT(30-1)-1238; F 44620-70-C-0033. Phys. Rev. Lett.; 28: No. 6, 340-3(7 Feb 1972).

A model is presented for the nonlinear evolution of the electron-plasma ion-acoustic decay instability when the ratio of electron and ion temperatures is of order 1. Ion nonlinear Landau damping is found to be the dominant saturation mechanism. The saturated spectral intensity and pump absorption coefficient are calculated. The energy that the enhanced fluctuations absorb from an electromagnetic wave incident on an inhomogeneous plasma is estimated. (auth)

19519 CROSS-FIELD CURRENT-DRIVEN ION ACOUSTIC INSTABILITY. Barrett, P. J.; Fried, B. D.; Kennel, C. F.; Sellen, J. M.; Taylor, R. J. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 28: No. 6, 337-40(7 Feb 1972).

The cross-field current-driven ion acoustic instability occurs when electrons and ions have a relative streaming velocity (along x) across a weak magnetic field. For certain ranges of conditions, the spatial growth rate is enhanced over the value with no field. Measurements of the growth rate in two different plasma configurations as a function of both field and frequency give results consistent with the linear dispersion relation for this instability. (auth)

19520 NONLINEAR PLASMA INSTABILITY EFFECTS FOR SUBHARMONIC AND HARMONIC FORCING OSCILLATIONS. Keen, B. E.; Fletcher, W. H. W. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., A (London); 5: No. 1, 152-65(Jan 1972).

Results are presented which show that a marginal ion sound instability in a plasma behaves in a manner similar to that predicted by a Van der Pol type of nonlinear equation, including anharmonic terms. Experiments were performed in which the system was subjected to an external driving force at the fundamental frequency ω_0, and the subharmonic frequencies, which showed that the instability exhibits characteristics similar to the classical nonlinear phenomena of "jumps" including the associated hysteresis effect. When the system is driven by a forcing oscillation at the harmonic frequencies $2\omega_0$ or $3\omega_0$, the instability behaves differently from linear forced resonance, and exhibits a behavior similar to a parametric oscillator. A theory developed to describe this ion sound instability under these various conditions, is compared with the experimental results, and good agreement is obtained. (auth)

19521 PURELY GROWING PARAMETRIC INSTABILITY IN AN INHOMOGENEOUS PLASMA. Fejer, J. A.; Leer, Egil (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 77: No. 4, 700-8(1 Feb 1972).

A simple method based on energy balance is used first to rederive the well-known threshold condition for the purely growing parametric instability in a homogeneous medium and later to estimate the effects of inhomogeneity in a semiquantitative manner. A method different from that of Perkins and Flick (1971) is then used to calculate the threshold in a more quantitative manner for the instance where the effects of inhomogeneity dominate over those of collisions. The result agrees with that of Perkins and Flick for $k_{||}l \gg 1$ in their terminology. For $k_{||}l \ll 1$, neither theory is directly applicable and the threshold is obtained by numerical methods. The present method of calculation has the advantages that its range of validity is easily checked, that it provides good physical insight, and that it is easily applicable to electromagnetic instabilities. (auth)

19522 PLASMA DESTABILIZATION EFFECT IN A CURVED MAGNETIC FIELD ASSOCIATED WITH A FINITE ELECTRON CONDUCTIVITY. Borisov, N. D.; Mikhailovskii, A. B. (Inst. of Atomic Energy, Moscow). Dokl. Akad. Nauk SSSR; 199: No. 2, 296-8(11 Jul 1971). (In Russian).

The curvature of the lines of force of a magnetic field may lead to instability even when the direction of the curvature is everywhere contrary to the pressure gradient of the plasma. This is demonstrated theoretically with the mathematical model of a field, thermal flow balance, ion–electron collision frequency, density gradient of the plasma, and related factors. (K.S.W.)

Thermonuclear Processes

19523 (CEA-R-4255) NUCLEAR FUSION REACTIONS IN LASER-PRODUCED PLASMAS. Bobin, Jean-Louis; Floux, Francis (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Dec 1971. 34p. (In French). Dep. NTIS (U. S. Sales Only).

Neutron emissions were observed in recent experiments on laser interaction with matter. This is an important stage in laser-produced plasma research. Such plasmas have both high temperatures and high densities. Moreover, when the laser pulse is not too short, photon absorption and matter heating take place in hydrodynamic conditions. The temperatures obtained increase with the flux. In experiments performed with a laser beam of a few gigawatts and in hydrodynamic conditions during the interaction with a solid deuterium target, nuclear fusion reactions were clearly observed. (auth)

19524 (CONF-711111–31) SOME ENGINEERING DESIGN CONSIDERATIONS FOR A THERMONUCLEAR POWER PLANT. Bonanos, P. (Princeton Univ., N. J. Plasma Physics Lab.). [1971]. Contract AT(30-1)-1238. 6p. Dep. NTIS.
From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

This survey describes the nature of the plasma power source in an engineering sense, lists some of the known problems requiring study, and illustrates several specific details in the design of toroidal fusion reactors. (auth)

19525 (CONF-711111–32) COMPUTER ASSISTANCE FOR EXPERIMENTS ON THE ST-MACHINE. Thompson, P. A.; Bennett, F. K. (Princeton Univ., N. J. Plasma Physics Lab.). [1971]. Contract AT(30-1)-1238. 9p. Dep. NTIS.
From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

An IBM-1800 computer was adapted by means of locally designed interfacing and control hardware (including a high-speed analog input mini-computer) and special software to perform for the ST Machine real-time collection and processing of data and immediate display of results. Feedback thus provided assists in parameter adjustments and overall guidance in the experimental run. (auth)

19526 (CONF-711111–33) POTENTIAL ADVANTAGES OF FUSION POWER REACTORS. Mills, R. G. (Princeton Univ., N. J. Plasma Physics Lab.). [1971]. Contract AT(30-1)-1238. 6p. Dep. NTIS.
From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

Environmental and economic advantages of a fusion power reactor are discussed. The discussions are on waste products, tritium hazard, activation, waste heat, fuel costs, reliability, capital costs, and a long-range viewpoint. (M.O.W.)

19527 (JUL–782-MA) NUMERICAL CALCULATION OF A TWO-DIMENSIONAL MAGNETIC LEAKAGE FIELD. Horlitz, E.; Weidner, P. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Angewandte Mathematik). Aug 1971. 27p. (In German). Dep. NTIS (U. S. Sales Only).

For solution of the Laplace equation in two-dimensional cartesian or cylindrical coordinates, a difference method was used. The system of equations obtained was resolved with the superrelaxation method. The discretization was so selected that randomly curved enveloped magnetic devices could be treated. Special considerations are necessary in order to obtain a finite problem. This occurs when the region is intercepted at suitable places, and boundary values were selected at these boundaries. This value appears on the basis of physical considerations. By variation of the boundary value, its effect on the magnetic field was tested in the region desired, and the boundary was displaced until its influence was negligible. The difference method yields the value of the potential at the selected lattice points. The components of the field intensity are then obtained by numerical differentiation. (tr-auth)

19528 OPTIMUM TEMPERATURES AND CRITICAL PARAMETERS OF A SELF-SUSTAINED REACTION IN A SOLID THERMONUCLEAR FUEL. Babykin, M. V.; Starykh, V. V. (Inst. of Atomic Energy, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1273-7(Feb 1972).
Translated from Zh. Tekh. Fiz.; 41: No. 8, 1618-23(Aug 1971).

An approximate energy-balance equation is used, taking account of radiation, to calculate the optimum temperatures at which the energy and power required to initiate a thermonuclear reaction by an external pulsed energy source are a minimum in a condensed D–T mixture and in substances containing a D–T mixture chemically bound with light elements such as Li and B. The temperature at which the power is at a minimum is itself a minimum, equal to 12.6 keV for the D–T mixture. The critical target volume and the critical energy and power required to initiate a reaction with a positive energy production are also calculated. Calculations carried out for the case of the free expansion of a spherical volume and for a cylindrical volume bounded by a solid shell show that the critical parameters are much lower in the latter case. (auth)

19529 BOUNDARY-VALUE PROBLEMS IN ASSOCIATION WITH FORCE-FREE MAGNETIC FIELDS IN ROTATIONALLY SYMMETRIC DECAY. Schaefer, D. (Univ., Bonn). Beitr. Plasmaphys.; 11: No. 4, 351-7(1971). (In German).

The question of the existence and uniqueness of the solutions of the system rot $H = \alpha H$ div $H = 0$ in the case of rotational symmetry can be reduced to the question of the resolvability of a nonlinear elliptic differential equation for α that contains an arbitrary function $g(\alpha)$. Under rather general suppositions, the boundary values of α and the function $g(\alpha)$ are given by the boundary values of H_φ and $H_\perp$ (the component of H which is perpendicular to the boundary). From the theory of nonlinear elliptic equations, the boundary-value problem has a unique solution in sufficiently small domains. For large domains, estimations about the diameter and area exist that guarantee the existence and uniqueness of the solutions. (auth)

19530 LEVITATED TOROIDAL MULTIPOLE DESIGN STUDY AND OPTIMIZATION. Steben, John D. (Univ. of Wisconsin, Madison). J. Appl. Phys.; 43: No. 3, 1211-17 (Mar 1972).

Designing a useful plasma toroidal multipole requires optimization of many parameters. The selection and design of the Wisconsin levitated octupole involved study of over 200 multipole configurations with a computer program based on the stream function $\psi = rA_\theta$. Plasma bridge thickness was maximized, subject to having equal MHD-stable flux inside and outside of the separatrices. To achieve sufficient outside flux in a quadrupole with reasonable stored energy and hoop weight requires hoops with a long and (radially) thin cross section. The field properties are then poor because of $\vec{E} \times \vec{B}$ drift into hoops. Octupoles do not have this problem, since (much lighter) hoops of circular cross section were essentially optimum. Sextupoles had disadvantages similar to quadrupoles. Octupole hoop levitation by the fields was achieved with two wall projections and no major sacrifice in outer flux. Perfect critical-point degeneracy was traded for improved horizontal injection geometry, but flux between separatrices was held to 1% of plasma flux. These criteria were satisfied independently of effective skin depth (up to 1.5 rms resistive skin depths at 10 Hz) of field penetration. Construction of the octupole was completed, and initial experiments largely confirmed the design qualities sought. (auth)

Wave Phenomena

Refer also to abstract 18679.

19531 (SCL–RR–710232) RAY TRACING AND GEOMETRICAL PROBABILITY. Schipper, J. F. (Sandia Labs., Livermore, Calif.). Sep 1971. Contract AT(29-1)-789. 82p. Dep. NTIS.

Mathematical modeling is developed for a system comprised of a random suspension of circles or spheres, using regular two- and three-dimensional arrays that allows one to incorporate volume exclusion of the bodies and to fill all space. A finite number of contiguous cells in either array is chosen as the system, and a smaller number among these cells is randomly designated as occupied. Mean length and $(\text{length})^2$ for rays traversing a single cell are calculated, and the probability distributions on traversal length for hexagons, circles, and spheres are developed. The distributions on traversal length for hexagons, circles, and spheres are developed. The distribution on occupied cells traversed by a single ray is also developed—the hypergeometric distribution, not the binomial as is usually alleged. The moment generating function is developed, as is the distribution G(x) for total length x traversed in occupied cells by a ray traversing a fixed number M of cells. The transmission factor T(L) through a system of thickness L is defined, and useful upper and lower bounds on T(L) for a class of attenuation factors (including, but not limited to, exponential attenuation) are adduced. The joint probability distribution for fluctuations of sample mean and variance about the population mean and variance is developed and applied to systems of two or more rays traversing the systems. Some new and old results from integral geometry (geometrical probability) are derived and applied in obtaining many of the foregoing results. The formalism is applied to propagation of electromagnetic signals in a system comprised of spherical cells of plasma immersed in a "normal" medium, as an example of the class of problems which may be studied by this approach. (auth)

19532 TRANSIENT PHENOMENA IN THE EXCITATION OF LOW-FREQUENCY OSCILLATIONS IN A PLASMA CYLINDER. Demchenko, V. V.; Stepanov, K. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1386-8(Feb 1972).
Translated from Zh. Tekh. Fiz.; 41: No. 8, 1755-8(Aug 1971).

A brief theoretical analysis is presented of transient processes occurring when weakly damped Alfvén (ion-cyclotron) waves and fast magneto-acoustic waves (helicons) are excited in an infinite plasma cylinder, when external currents are switched on in a coil of finite length. (M.O.W.)

19533 PLASMA OSCILLATIONS IN A PLASMA PRODUCED BY AN ION BEAM. Gabovich, M. D.; Soloshenko, I. A. (Inst. of Physics, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1281-4(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1627-31(Aug 1971).

A plasma produced by ionization due to an ion beam can propagate electron plasma waves if the ion-beam velocity exceeds the electron thermal velocity. High-frequency oscillations can also be excited by an electron beam. The excitation of the oscillations is accompanied by a deterioration of the neutralization of the beam ions. (auth)

19534 EXPERIMENTAL OBSERVATION OF ELECTRONIC SHOCK WAVES IN A COLLISIONLESS PLASMA. Ivanov, A. A.; Kozorovitskii, L. L.; Rusanov, V. D.; Sagdeev, R. Z.; Sobolenko, D. N. JETP Lett. (USSR) (Engl. Transl.); 14: No. 11, 412-15 (5 Dec 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 11, 593-6(5 Dec 1971).

Earlier, the authors demonstrated experimentally the existence of collisionless thermal waves in a plasma; also, the occurrence of ion-acoustic noise on the front of a thermal wave was noted, i.e., the feasibility of a stationary discontinuity was demonstrated. Here, the experimental proofs of the existence of a stationary heat discontinuity in a collisionless plasma (electronic shock wave) and the relation of its parameters with the theoretical concepts are considered. (L.M.T.)

19535 REFRACTION OF THE EXTRAORDINARY WAVE IN A CROSS SECTION OF AN ANISOTROPIC PLASMA CYLINDER. Dushin, L. A.; Skibenko, A. I.; Fomin, I. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1291-5(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1640-6(Aug 1971).

Experiments are described at $\lambda = 8.1$ mm and 14.3 mm with different polarization, for magnetic fields from 1.5 to 14 kOe in a plasma cylinder 100 mm in diameter. The refraction of the extraordinary wave can be used to expand the range of measurement of plasma density to lower values for $u < 1$ and higher values for $u > 1$. (auth)

19536 NONLINEAR IONIZATION WAVES. Grabec, I. (Univ., Ljubljana, Yugoslavia. Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Beitr. Plasmaphys.; 11: No. 4, 285-94(1971).

A nonlinear ionization wave equation is derived that includes a nonlinear form of the ionization rate instead of a corresponding linear term in the equation of Pekárek and Kreičí (Czech. J. Phys., B12: 450(1962) and B13: 882(1963)). The nonlinear response of an unstable positive column to a weak pulse disturbance is then numerically calculated in order to study the transition from the linear to the nonlinear wave of stratification. The solutions obtained reproduce some well-known features of nonlinear ionization waves. (auth)

19537 EFFECT OF TRAPPED PARTICLES ON THE NONLINEAR EVOLUTION OF A WAVE PACKET. Denavit, J.; Sudan, R. N. (Naval Research Lab., Washington, D. C.). Contract AT(30-1)-4077. Phys. Rev. Lett.; 28: No. 7, 404-7(14 Feb 1972).

Numerical simulations were made of the evolution of a large-amplitude electrostatic wave packet in a hot collisionless plasma. When resonant particles are trapped by the wave potential during a transit time, the number of lobes in the packet is observed to increase. This is explained in terms of an equation of propagation for the packet amplitude and a dispersion relation involving the trapped particles. (auth)

19538 DIRECT OBSERVATION OF WAVES PROPAGATING NEAR THE LOWER-HYBRID-RESONANCE FREQUENCY. Hooke, W. M.; Bernabei, S. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Rev. Lett.; 28: No. 7, 407-10(14 Feb 1972).

Electrostatically driven oscillations near the lower-hybrid-resonance frequency were studied in a linear plasma device. The index of refraction of these waves is measured directly and is seen to peak at a critical density as the wave propagates radially inward. A strong, nonlinear interaction is observed between the driven oscillations and the low-frequency drift-wave-like fluctuations that exist in this plasma. (auth)

19539 NONLINEAR FREQUENCY SHIFT OF AN ELECTRON PLASMA WAVE. Morales, G. J.; O'Neil, T. M. (Univ. of California, San Diego, La Jolla). Contract AT(04-3)-34. Phys. Rev. Lett.; 28: No. 7, 417-20(14 Feb 1972).

The shift in the complex frequency of a large-amplitude electron plasma wave is formulated in terms of a new subtraction procedure, which reproduces the damping coefficient of Mazitov and of O'Neil directly from Poisson's equation. A time-dependent frequency shift is obtained that produces a phase shift that should be amenable to experimental observation. The results are interpreted in terms of simultaneous conservation of momentum and energy in the wave frame. (auth)

19540 PROPAGATION OF AN ION SOUND WAVE IN PRESENCE OF A LARGE NEUTRAL BACKGROUND. Aldridge, R. V. (Univ. of East Anglia, Norwich, Eng.). Phys. Lett.; 38A: No. 4, 239-40(14 Feb 1972).

The case is taken of an ion wave in a single-component weakly ionized plasma. Collisional effects on the ions are also included. (auth)

19541 INTERACTION OF ION AND ELECTRON WAVES WITH EMISSION AT SINGLE AND DOUBLE PLASMA FREQUENCIES. Beermann, D. (AEG-Telefunken, Ulm, Ger.). Z. Naturforsch.; 26a: No. 11, 1909-18(Nov 1971). (In German).

Nonlinear interactions of longitudinal plasma waves in two-fluid plasma exciting the solar Type-II burst emission are investigated. The interaction of ion and electron waves yields radiation at the fundamental plasma frequency, while emission at twice the plasma frequency is caused by self-interaction of the electron waves. Equal flux intensity results in both the radiation bands if the variation of electron density associated with the two wave modes is of the same order of magnitude. (auth)

19542 ION WAVES IN ELECTROGASDYNAMIC FLOWS OF POISEUILLE AND HAGEN–POISEUILLE TYPE. Brunne, Marek. Pr. Inst. Masz. Przeply.; No. 54-55, 215-47(1971). (In Russian).

An analysis of ion oscillations in EGD flows in channels is given. Use is made of the two-fluid model of transport equations for isothermal unipolar fluid. In the linearization of the equations, a restriction is made to only one step of the perturbation analysis, the degree of ionization being regarded as a small parameter. Some particular cases, especially equations for the dispersion of electrostatic ion waves propagating within the considered flows, are derived and discussed. In addition, forced vibrations of ions are the subject of discussion for an interesting form of initial disturbance of ion concentration in the flow. (auth)

19543 REFLECTION OF ELECTROMAGNETIC AND PLASMA WAVES AT THE INTERFACE BETWEEN A MOVING DIELECTRIC MEDIUM AND A COMPRESSIBLE PLASMA. Kojima, T.; Tiakura, K.; Higashi, T. (Osaka Univ.). J. Appl. Phys.; 43: No. 3, 1309-10(Mar 1972).

As one problem which relates to the interaction of electromagnetic waves with plasma waves at the interface between a compressible plasma and a dielectric medium, the reflection problem is considered for the case where a plane electromagnetic wave is incident from the compressible plasma region into the moving dielectric half-space. It is well known that there exist two kinds of reflected waves, i.e., electromagnetic wave and plasma. Therefore, the effects of the motion of the dielectric half-space on the above two reflected waves are investigated. (M.O.W.)

19544 RESONANT EXCITATION OF ION PLASMA WAVES BY VLF AND WHISTLER WAVES. Tripathi, V. K.; Kamal, J. (Indian Inst. of Tech., New Delhi). J. Phys., A (London); 5: No. 1, 146-51(Jan 1972).

The reactive mechanism of nonlinear wave mixing was used to excite ion plasma oscillations in a nonisothermal magnetoplasma. Input waves were transverse and belonged to the low-frequency regime. It is shown that the resonance conditions are relatively easier to satisfy over a wide range of plasma and wave parameters in the case of the mixing of whistlers. The amplitude of the generated signal is high at moderately strong lf waves. With increasing generated frequency it shows a continuous decrease. (auth)

19545 CYLINDRICAL GRAVITATIONAL WAVE IN A HOT-PLASMA CONFINED IN A MAGNETIC FIELD: CONDITIONS OF INSTABILITY. Vacca, Maria Teresa. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 105: No. 5-6, 785-95(Sep-Dec 1971). (In Italian).

Modes of propagation of a gravitational wave in a hot plasma confined in an arbitrary circular cylinder and subjected to a uniform axially symmetric magnetic field are studied theoretically. (tr-auth)

19546 AMPLITUDE DEPENDENCY OF ELECTROSTATIC WAVE PROPAGATING PERPENDICULARLY TO MAGNETIC

FIELD. Ohnuma, T.; Miyake, S.; Watari, T.; Sato, T. (Nagoya Univ., Japan). Phys. Lett.; 38A: No. 3, 191-2(31 Jan 1972).

In the electrostatic ion wave propagating perpendicularly to a magnetic field, wave damping with a change of the exciting voltage was observed, results of which are similar to those in the case of no magnetic field. (auth)

19547 ALFVEN WAVE LENGTH DEPENDENCE ON THE GEOMETRY OF NONHOMOGENEOUS PLANE MAGNETIC FIELD IN A STATIONARY PLASMA. Petrus, O. (Univ., Iasi). Stud. Cercet. Fiz.; 22: No. 4, 353-8(1970). (In Rumanian).

The Alfvén wavelength was studied for plasmas in inhomogeneous magnetic fields using conformal transformations. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 18481 and 18508.

19548 (EGG-1183-2275) MOMENTS METHOD CALCULATION OF THE SCATTERED ANGULAR ENERGY FLUX FOR POINT ISOTROPIC GAMMA SOURCES IN AN INFINITE HOMOGENEOUS AIR MEDIUM. O'Dell, A. A. (EG and G, Inc., Goleta, Calif.). Jul 1971. Contract AT(29-1)-1183. 218p. Dep. NTIS.

An improved moments-method analysis technique was developed to calculate the scattered angular energy flux distribution for point isotropic gamma sources in an infinite homogeneous air medium. Starting with a numerical tabulation of total scattered plane isotropic source moments, the singly scattered moments are evaluated and subtracted out. The resulting more-than-once (2+) scattered moments are then converted to point source moments, and Legendre coefficients are reconstructed by expansion in biorthonormal U polynomials. The 2+ angular energy flux is then reconstructed by a Legendre expansion and added to the singly scattered angular energy flux obtained from an analytical expression due to Fano, Spencer, and Berger. Results are presented for 15 source energies ranging between 0.1 and 3.0 MeV. For each source energy 15 scattered energies, 10 distances-to-source (1 to 30 mfp), and 90 angles (2 to 180°) are used in the computations. The effects of series truncation were studied and are discussed in detail. Comparisons are made with a previous exploratory calculation performed by Spencer and Stinson. The computational procedures developed in this study have been incorporated into the FLUX computer code which can be readily utilized to extend the calculations to other energies, distances-to-source, and observation angles. (auth)

19549 BREMSSTRAHLUNG, CHERENKOV RADIATION, AND TRANSITION RADIATION FROM A THIN FOIL. Heitmann, D. (Univ., Hamburg). Z. Phys.; 249: No. 4, 356-72(1972). (In German).

A formula for the coherent emission of bremsstrahlung, Cherenkov radiation, and transition radiation of a single electron traversing a thin foil at an oblique angle of incidence and changing its velocity (direction or amount) inside the foil is presented. The bombardment of silicon foils with 50-keV electrons is considered as an example. The statistical scattering of the electrons inside the foil is taken into account by means of a measured scattering pattern. (9 figures) (auth)

19550 INVESTIGATION OF THE SLOWING DOWN OF POSITIVE IONS IN SILICON CARBIDE. Makarov, V. V.; Petrov, N. N. (Leningrad Polytechnic Inst.). 14Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 3, 447-9(Sep 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 3, 510-13(Mar 1971).

Hydrogen, deuterium, helium, lithium, sodium, and potassium ions of up to 20 keV energies were directed onto silicon carbide single crystals. Information was obtained on the depths of penetration of these ions into SiC and on the number of electron–hole pairs excited by them. The measured values of the ion range and of the energy expended in inelastic collisions were compared with the results of calculations based on the theory of Lindhard et al. (auth)

19551 Z_2 DEPENDENCE OF STOPPING CROSS SECTIONS FOR LOW-ENERGY ALPHA PARTICLES. Chu, W. K.; Powers, D. (Baylor Univ., Waco, Tex.). Phys. Lett.; 38A: No. 4, 267-8(14 Feb 1972).

Calculation of α-particle stopping cross sections based on the theory of Lindhard and Winther using the Hartree–Fock–Slater atomic-charge distribution is made at $E_\alpha = 0.8$ to 20 MeV for all elements. Comparison with experimental results is given at $E_\alpha = 4$ MeV. (auth)

19552 PENETRATION AND ENERGY-LOSS THEORY OF ELECTRONS IN SOLID TARGETS. Kanaya, K.; Okayama, S. (Electrotechnical Lab., Tokyo). J. Phys., D (London); 5: No. 1, 43-58(Jan 1972).

Starting from a simple atomic model giving the potential between electrons and atoms as $V(r) = Ze^2a^{s-1}/sr^s$ with the empirical value $s = 6/5$, the diffusion effect due to multiple collisions and the energy retardation in accordance with a modified Thomson–Whiddington law are combined with the scattering cross section in the Lenard absorption law. On this basis, consistent expressions are obtained for the fraction of transmitted electrons in amorphous solid targets, the backscattering fraction with depth, the fraction of electrons absorbed per unit mass-thickness, and the depth-dose function, which are in good agreement with experiments over the energy range 10 to 1000 keV. A diffusion model represented by a sphere whose centre is located at the maximum energy dissipation depth, related to the diffusion depth and the range, is found to agree well with experiments. (auth)

Radiation Protection Standards

Refer also to abstract 17836.

19553 NEW LOOK AT BASIC RADIATION STANDARDS. Snow, Donald L. (Bureau of Radiological Health, Rockville, Md.). Amer. J. Public Health; 61: No. 11, 2294-9(Nov 1971).

The development of radiation standards, the criteria to be employed, and the problems to be solved are discussed. (auth)

Radiation Source Calibration and Standardization

Refer also to abstracts 18042, 18075, 18080.

19554 SIMPLE TWO-DETECTOR METHOD FOR PRECISION INTERCOMPARISONS OF SOURCE STRENGTHS. Valkonen, M.; Kantelle, J. (Univ., Jyvaeskylae, Finland). Nucl. Instrum. Methods; 99: No. 1, 25-7(1972).

A two-detector method for comparing source strengths which largely eliminates errors due to uncertainties of geometric character is described. The simplest version of the method is based on the fact that, when a symmetric face-to-face geometry is being used, the change of the counting rate of one detector caused by the change of the position of the source is approximately compensated for by the change of the counting rate of the other detector. In a more versatile geometry, in which the axes of the detectors are slightly misaligned, the sum and the ratio of the two counting rates can be used in a simple manner to virtually eliminate uncertainties due to the shapes and horizontal positions of point, line, and disc sources. (5 figures) (auth)

Shielding Calculations and Theory

Refer also to abstract 18446.

19555 (AD-713019) EFFECTS OF FINITE-SOURCE FIELDS ON RADIATION DOSES IN A STRUCTURE. Final Report. Veletri, Joseph; Spring, Robert (CGS Scientific Corp., Watertown, Mass. Datametrics Div.). Jul 1970. Contract DAHC20-70-C-0227. 98p. (CGS-TR-30). NTIS.

An experimental study was made to obtain information that could be used to evaluate the present method of predicting dose rates in structures from finite fields of contamination. The results of these experiments were compared with reduction factors calculated by the "engineering" and CONSTRIP methods. There is general agreement on the first story of the structure between experiment and both methods. There is a sizeable discrepancy between experiment and EM theory on upper stories, while the CONSTRIP results are in good relative agreement with experiment. Calculations for predicting the effects of "pile-up" on dose rates in structures agree well with the above-ground experimental results, but are a factor of three higher than the experimental results for below-ground shelter areas. (auth) (USGRDR)

19556 (ORNL-TM-3659) SHIELDING AGAINST NEUTRONS IN THE ENERGY RANGE 15 TO 75 MeV. Roussin, R. W.; Alsmiller, R. G. Jr.; Barish, J. (Oak Ridge National Lab., Tenn.). Dec 1971. 21p. Dep. NTIS.

Coupled neutron and gamma-ray transport calculations were performed using the discrete ordinates code ANISN for monoenergetic neutrons normally incident on a thick slab shield of concrete with 5.5% water content by weight. The transport of gamma rays produced in interactions by neutrons with energy greater than 15 MeV was neglected, but the transport of gamma rays produced by neutrons with energies less than 15 MeV was explicitly treated. For incident neutron energies of 15, 25, 50, and 75 MeV, results of total and gamma-ray dose equivalents are

given as a function of depth into the slab. For the 50- and 75-MeV incident neutron energies, the gamma-ray dose equivalent was found to be no more than 5% of the total dose equivalent at all depths considered (≤1500 g/cm^{-2}). For the 15- and 25-MeV incident neutron energies, however, the gamma-ray dose equivalent dominates at greater depths into the slab. A conservative estimate of the effect of including gamma rays produced in interactions with neutrons of energy greater than 15 MeV indicates that the calculated total dose equivalent would increase by no more than 2%. (auth)

PHYSICS (SOLID-STATE)

Refer also to abstracts 17896, 18707, and 19550.

19557 SOLID-STATE PHYSICS. VOLUME 26. ADVANCES IN RESEARCH AND APPLICATIONS. Ehrenreich, Henry; Seitz, Frederick; Turnbull, David (eds.). New York; Academic Press Inc. (1971). 506p. $27.50.

Four review articles are included, whose subjects are: calculation of Bloch functions, calculation of electronic energy bands by the augmented-plane-wave method, plasmas in solids, and ferroelectricity and symmetry. A separate abstract was prepared for the article on plasmas in solids. Author and subject indexes are included. (D.L.C.)

For an abstract of an individual chapter see: 19635.

Radiation Effects

19558 HYDROGEN DEFECTS IN PROTON-BOMBARDED KCl. Chu, Y. Hou; Friauf, R. J.; Zeller, E. J. (Univ. of Kansas, Lawrence). Phys. Lett.; 38A: No. 3, 179-80(31 Jan 1972).

Optical absorption bands were observed in the uv and ir regions of proton-bombarded KCl at liquid-nitrogen temperatures. It was demonstrated that the absorption is due to trapped protons, and the largest uv band was identified with the U center. (auth)

19559 ROLE OF POSITIVE ION VACANCIES AND F CENTERS IN POSITRON ANNIHILATION IN KCl. Mallard, W. C.; Hsu, F. H. (Georgia State Univ., Atlanta). Phys. Lett.; 38A: No. 3, 164-6(31 Jan 1972).

Positron lifetime spectra for good-quality, high-purity crystals were resolved into three components. The two shorter-lived components are independent of radiation-induced defects. Only τ_3 and I_3 are affected by changing the positive-ion vacancy and F-center concentrations over wide ranges. (auth)

19560 MONTE CARLO SIMULATIONS ON SCATTERING OF BOMBARDED IONS IN SOLIDS. Ishitani, Tohru; Shimizu, Ryuichi; Murata, Kenji (Osaka Univ., Suita, Japan). Jap. J. Appl. Phys.; 11: No. 2, 125-33(Feb 1972).

By taking account of not only an elastic scattering but also an inelastic scattering, the Monte Carlo technique based on a single scattering model is applied to a simulation of the behavior of ion beam in the amorphous target. The calculations are carried out for light-ion beams mainly, and the results show a fairly good agreement with the experiments on the range and the backscattering. Also, ion trajectories are depicted on the chart by the plotter connected with the digital computer to get a direct view of the scattering processes in solids. (auth)

19561 INVESTIGATION OF INTERSTITIAL Zn CONCENTRATIONS IN ADDITIVELY COLORED ZnO USING THE UNI-DIRECTIONAL CHANNELING AND BLOCKING TECHNIQUE. Appleton, B. R. (Oak Ridge National Lab., Tenn.); Feldman, L. C. J. Phys. Chem. Solids; 33: No. 2, 507-17(Feb 1972).

A new experimental technique, which combines the channeling and blocking phenomena of energetic ions in single crystals, was utilized to investigate the concentration of Zn interstitials in additively colored ZnO single crystals. This method, called the unidirectional channeling and blocking technique, is directly sensitive to Zn interstitials and is useful in determining not only the concentration of such defects but their lattice position as well. The measurements showed no evidence of Zn interstitials along either the Z or X axial directions of the additively colored crystals in concentrations $\geq 6 \times 10^{18}$ interstitials/cm^3. This limit is two orders of magnitude less than the concentrations reported by Mohanty and Azároff (J. Chem. Phys., 35: 1268(1961)) from measurements of the x-ray diffraction intensities for colored and uncolored ZnO crystals. They reported interstitial concentrations along the Z-axis direction of the additively colored ZnO of 1.6 to 6×10^{20} interstitials/cm^3. The implications of these measurements are discussed and compared to related results. (auth)

19562 LUMINESCENCE OF GaSe UNDER INTENSE EXCITATION BY AN ELECTRON BEAM. Ugumori, T.; Masuda, K.; Namba, S. (Osaka Univ.). Phys. Lett.; 38A: No. 2, 117-18 (17 Jan 1972).

An extra luminescence band is observed in GaSe under intense excitation by an electron beam at 86 to 275°K. The additional luminescence band is considered to be due to an exciton–exciton interaction process. (auth)

19563 LUMINESCENCE AND OPTICAL PROPERTIES OF SILICON CARBIDE IRRADIATED WITH FAST NEUTRONS. Makarov, V. V. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 1974-9(Feb 1972). Translated from Fiz. Tverd. Tela; 13: No. 8, 2357-63(Aug 1971).

Crystals of silicon carbide containing radiation defects responsible for the characteristic luminescence spectrum and the line structure of the absorption spectrum were studied. It was found that the observed spectra are well described by the theory of electronic transitions in localized centers. The positions of the ground- and excited-state levels of these centers, the electron–phonon interaction constant, and the excess-carrier capture coefficients of the corresponding levels were determined. The large role of phonon effects in the luminescence of SiC is noted. (auth)

19564 INFRARED SPECTROSCOPY OF DIVACANCY-ASSOCIATED RADIATION-INDUCED ABSORPTION BANDS IN SILICON. Chen, C. S.; Corelli, J. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., B; 5: No. 4, 1505-17(15 Feb 1972).

Defect infrared-absorption bands induced by fast neutrons in n-type, p-type, and intrinsic silicon were investigated by the piezospectroscopic method. The divacancy-associated bands at 1.8 and 3.3 μ, together with two sharp subbands at 3.45 and 3.61 μ, were observed in all types of Si when the measurements were made below 150°K. When measurements were made at 300°K, the 1.8-μ band was observed in all samples while the 3.3-μ band was observed only in n-type Si. The 3.9-μ band, which has been identified to be associated with the +1 charge state of the divacancy defect, was not observed. Detailed temperature-dependence studies of the fine structures of the 3.3-μ band give no evidence of phonon structure. The fine structures of the 3.3-μ band are not associated with a single-2 charge state of the divacancy, as previously reported, but rather are due to three different optical transitions. It is concluded that the charge state of the divacancy defect responsible for the observation of these bands is not the same everywhere in the sample. Detailed low-temperature-stress studies of the absorption bands utilizing polarized light lead to large dichroism and small splitting for the 3.4- and 3.61-μ sharp bands, with smaller dichroism and large splitting for the 1.8-μ band. Stress-induced splitting of the bands at 78°K leads to a confirmation of the model of the divacancy defect deduced from electron-paramagnetic-resonance (EPR) studies by Watkins and Corbett. In terms of a one-electron molecular-orbital model of energy levels, the bands at 1.8, 3.45, and 3.61 μ are identified as associated with the X–Y dipole-moment transitions. The 3.3-μ band arises from an optical transition due to ionizations of electrons from the weak-orbital-bonding state to the nearest conduction-band edge. (auth)

19565 PHOTOCONDUCTIVITY STUDIES OF RADIATION-INDUCED DEFECTS IN SILICON. Young, R. C.; Corelli, J. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., B; 5: No. 4, 1455-67(15 Feb 1972).

The annealing behavior and the uniaxial-stress responses of the radiation-induced defect causing the $E_c - 0.75$-, $E_c - 0.54$-, $E_c - 0.42$-, and $E_c - 0.18$-eV photoconductivity energy levels in n-type silicon were studied after 1.5-MeV electron and ^{60}Co γ-ray irradiation at 300°K. The results suggest that the $E_c - 0.75$-eV level arises from the electronic transition of the neutral charge state of the divacancy to the conduction band. This level also occurs in heavily irradiated p-type silicon when the Fermi level is too high to observe the divacancy-associated 0.32-eV photoconductivity band. The $E_c - 0.75$-eV level is found to be correlated with the 0.32-eV band, indicating that they are due to two different charge states of the same defect. The $E_c - 0.18$-eV level arises from the A-center defect which exhibits only one kind of stress response, i.e., the atomic redistribution among the allowable orientations. No electronic response was observed for the A center in the photoconductivity measurements. The data fit very well with the A-center model derived from electron-paramagnetic-resonance studies. The $E_c - 0.42$-eV level was quite complicated. Besides the radiation-induced divacancy defect located near this level, evidence is presented that some additional trap center inherent as an in-grown defect in the sample also gives rise to this level. The $E_c - 0.54$-eV level anneals out around 150°C. Whether it really arises from the singly charged state of the divacancy or not is still a question. (auth)

19566 THEORETICAL CONSIDERATIONS ON LATERAL SPREAD OF IMPLANTED IONS. Furukawa, Seijiro; Matsumura, Hideki; Ishiwara, Hiroshi (Inst. of Tech., Tokyo). Jap. J. Appl. Phys.; 11: No. 2, 134-42(Feb 1972).

A theoretical analysis is presented on the lateral spread of the distribution for implanted ions in amorphous targets. First, it is

shown that the solutions of the second-order differential equations concerning moments of the ranges are necessary and sufficient to estimate the lateral distribution, if a Gaussian distribution is assumed. The calculated results of $\langle R_p \rangle$, $\langle \Delta R_p \rangle$, and the lateral spread are presented. Next, it is shown that the actual distribution function along the lateral direction is approximately expressed by the complementary error function at the window edge, in the case when ions are implanted through the mask window. The variation of the lateral spread with incident ion mass is also calculated. From these calculations, it is concluded that the lateral spread cannot be neglected in the case of light ions such as B^+ incident on Si. (auth)

19567 DIRECT OBSERVATION OF THE FORMATION OF POINT-DEFECT CLUSTERS IN NICKEL DURING ELECTRON IRRADIATION BELOW ANNEALING STAGE I. Urban, K. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Status Solidi (b); 49: No. 1, K1-3(1 Jan 1972).

Pure Ni foils were irradiated in an electron microscope with 650-keV electrons at 8 to 9°K. Bright-field and weak-beam images show the appearance of dots and spots with irradiation, and changes in the selected-area diffraction pattern also occur, with disappearance of the Kikuchi lines. Some tentative remarks about the probable mechanism of the development of the spot contrast are made. The results indicate that clustering of defects is possible at temperatures far below I_E, the lowest annealing stage associated with free migration of point defects. (D.L.C.)

19568 INFLUENCE OF DISLOCATIONS ON THE KINETICS OF THE ACCUMULATION OF RADIATION DEFECTS IN GERMANIUM. Smirnov, L. S.; Stas, V. F.; Khainovskaya, V. V. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 1, 70-4(Jul 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 1, 85-90(Jan 1971).

The role of dislocations and their impurity atmospheres in the formation of complexes in germanium was investigated under conditions of fast-electron (3.5 MeV) bombardment. It was found that the rate of introduction of radiation defects, which were responsible for the changes in the carrier density and in the microhardness, was strongly affected by dislocations and by accidental impurities forming atmospheres around dislocations. The behavior of crystals during irradiation could be controlled to some extent by varying the density of dislocations or the state of their impurity atmospheres. The results were explained by means of a model based on the assumption of a competition between various lattice imperfections in the process of the capture of simple radiation defects. (auth)

19569 SOME FEATURES OF RADIATION-DEFECT ACCUMULATION DURING ION BOMBARDMENT OF CRYSTALS. Pridachin, N. B.; Smirnov, L. S. (Inst. of Physics of Semiconductors, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 1, 142-3(Jul 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 1, 166-8(Jan 1971).

A qualitative model is described for the processes that accompany the implantation of ions in crystals. The model predicts the formation of surface layers enriched locally with excess vacancies. The model is supported by many experimental observations. (D.L.C.)

19570 COMPENSATION OF THE ELECTRICAL CONDUCTIVITY BY RADIATION DEFECTS IN SEMICONDUCTORS. Vinetskii, V. L.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 1, 153-4(Jul 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 1, 176-8(Jan 1971).

A correlation between the radiation effects on the electric conductivity of a semiconductor and its forbidden-band width is pointed out. The compensation of the conductivity by the radiation defects is shown to be greatest for the defects with the deeper levels in wide-gap semiconductors; this is confirmed by observations. (D.L.C.)

19571 INFLUENCE OF IRRADIATION INTENSITY ON ACCUMULATION OF RADIATION DEFECTS IN SILICON. Panov, V. I.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 2, 300-1 (Aug 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 2, 346-9(Feb 1971).

The model with a barrier preventing the annihilation of vacancies and interstitials is described. In order to refine this model, the effects of the irradiation intensity (800-keV electrons) on the electric resistivity and microhardness of P-doped Si were studied experimentally. The resistivity change increased with the electron beam intensity, while above a certain dose, the microhardness was independent of the beam intensity. The results indicate that the formation of electrically active centers was not the dominant process. (D.L.C.)

19572 LUMINESCENCE CENTERS IN IRRADIATED β-SiC. Geitsi, I. I.; Nesterov, A. A.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 3, 439-42(Sep 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 3, 502-5(Mar 1971).

A study was made of the influence of irradiation with 3.5- and 0.4-MeV electrons on the luminescence of cubic silicon carbide. A new luminescence band (2 to 1.3 eV) was shown to be mainly due to four independent structure defects which were associated with the zero-phonon lines A_0, B_0, C_0, and D_0. The thermal stability of these defects was investigated. The annealing activation energy (2.2 eV) was determined for the type C defects. Irradiation was found to stimulate formation of the type A defects, which could not be annealed. A comparison of the results of irradiation with 3.5- and 0.4-MeV electrons and of subsequent annealing made it possible to attribute the type A centers to a defect containing a silicon vacancy of the β-SiC lattice. (auth)

19573 PHOTOELECTRIC PROPERTIES OF Si IRRADIATED WITH 660-MeV PROTONS. Vorobeichik, V. A.; Konopleva, R. F.; Novikov, S. R.; Rubinova, E. E. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 3, 397-402(Sep 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 3, 455-61(Mar 1971).

The impurity photoconductivity spectra were determined for n- and p-type Si crystals irradiated with 660-MeV protons (total absorbed dose from 8.8×10^{11} to 1.2×10^{15} protons $\times$ cm^{-2}). This investigation was carried out in the wavelength range 1 to 5 μ at 77°K. It was found that two and 11 defect levels were introduced respectively, into the forbidden bands of n- and p-type Si. Some of these levels were identified. In addition to the discrete levels, the impurity photoconductivity of n-type Si indicated the presence of a continuous spectrum of energy levels which could be attributed to the formation of disordered regions with a Fermi level located at about $E_v + 0.4$ eV. The manifestation of a larger number of energy levels in the photoconductivity of p-type Si, compared with that of n-type Si, was probably due to the masking of the spectrum of simple defects by the disordered regions or due to a considerable difference between the mobilities of the simple defects (vacancies or divacancies) in n- and p-type Si at the irradiation temperature (~300°K). (auth)

19574 NEUTRON-RADIATION DEFECTS IN OXYGEN- AND CARBON-DOPED SILICON. Dzhafarov, T. D. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 4, 697-8(Oct 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 4, 787-9(Apr 1971).

Effects of fast-neutron irradiation and isochronal annealing on the infrared vibrational spectra of n-type Si containing O and C impurities were studied. The irradiation increased the resistivity and changed the conduction to p-type, and changes in the absorption spectra were followed using the differential-transmission method with control samples as reference. Following irradiation, the intensities of the C and O peaks (605 and 1110 cm^{-1}) were reduced, and several new peaks were produced, including the 835 cm^{-1} peak of A centers. Annealing up to 300°C further added to those changes, but above 300°C the A centers were destroyed and a new peak at 890 cm^{-1} was produced, with conversion back to n-type conduction. The A-center creation was due to transformation of the interstitial O into O–vacancy complexes. The formation of Si–interstitial O–C and Si–vacancy O–C complexes is discussed. (D.L.C.)

19575 INFLUENCE OF NEUTRON AND γ-RAY IRRADIATION ON THE PROPERTIES OF HIGH-RESISTIVITY SILICON GROWN IN A HYDROGEN ATMOSPHERE. Konozenko, I. D.; Levchuk, L. V.; Galushka, A. P.; Krivrich, V. I. (Inst. of Nuclear Research, Kiev). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 4, 657-9 (Oct 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 4, 747-50(Apr 1971).

Effects of ^{60}Co γ rays and fast neutrons on the electric properties (electric conductivity, carrier mobility, carrier lifetime, and distribution of resistivity) of p-type Si single crystals prepared in a H atmosphere were studied. The effects of γ irradiation on the hole density and the lifetime indicated the formation of a defect at $E_v + 0.34$ eV; the defect is probably a divacancy related in some way to the H atoms present. The distribution of the resistivity before irradiation exhibited considerable inhomogeneities, probably due to nonuniform compensation of boron by

H atoms. Gamma irradiation produced a uniform, low distribution that was unaffected by annealing, whereas neutron irradiation produced the opposite effect (highly increased, highly heterogeneous distribution) that could be annealed out. (D.L.C.)

19576 ETCHING-METHOD INVESTIGATION OF THE DEFECT STRUCTURE OF SILICON IRRADIATED WITH FAST NEUTRONS. Kharchenko, V. A.; Solov'ev, S. P.; Voronov, I. N.; Kuz'min, I. I.; Smirnov, B. V. (Physical-Technical Inst., Moscow). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 4, 639-43(Oct 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 4, 730-5(Apr 1971).

Silicon samples grown by various methods were irradiated in a nuclear reactor. It was established that the density of the etch pits and their shape depended on the method of growth, on the technology of irradiation, and on the subsequent heat treatment. The observed changes in the defect structure of silicon were interpreted on the assumption of an interaction between the radiation defects and the defects formed during crystal growth. (auth)

19577 INVESTIGATION OF TRAPPING PHENOMENA IN n- AND p-TYPE GERMANIUM IRRADIATED WITH 660-MeV PROTONS. Evseev, V. A.; Konopleva, R. F.; Yuferev, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 4, 625-8(Oct 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 4, 714-18(Apr 1971).

Measurements of the steady-state photomagnetic effect and of the photoconductivity were used to investigate trapping phenomena in n- and p-type germanium crystals irradiated with 660-MeV protons. Strong trapping of the minority carriers by a level located at $E_c - 0.26$ eV was observed in the irradiated samples of n-type germanium. The ratio of the hole- to the electron-capture cross sections σ_p/σ_n and the temperature dependence of this ratio $\sigma_p/\sigma_n \propto \exp(0.03/kT)$ were determined and the charge of the centers responsible for this level ($z = 2$) was deduced. Trapping in the irradiated samples of p-type germanium was much weaker. The ratio of the hole- to the electron-capture cross sections of a trapping level in these samples was found to be practically independent of the temperature. It was concluded that the trapping of electrons in the irradiated p-type samples probably occurred at the $E_c - 0.12$ eV level, which was known from earlier electrical and photoelectric measurements. (auth)

19578 FORMATION OF DEFECTS IN GaAs DURING LOW-TEMPERATURE IRRADIATION WITH γ RAYS AND ELECTRONS. Brailovskii, E. Yu.; Konozenko, I. D. (Inst. of Nuclear Research, Kiev). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 4, 563-8 (Oct 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 4, 641-7(Apr 1971).

The effects on the electrical properties of GaAs single crystals of irradiation with ^{60}Co γ rays at 77°K and with 0.4- to 1.0-MeV electrons below 100°K were studied. It was established that γ irradiation of n-type GaAs produced defects that were annealed at ~500°K, as well as low-temperature defects that were annealed at ~230°K. The activation energy of annealing of the low-temperature defects was 0.4 ± 0.1 eV. The low-temperature defects were not observed in p-type GaAs. Irradiation of p-type GaAs with γ rays caused a considerable rise of the electric conductivity σ, which was attributed to trapping processes. The dependences of the rate of removal of carriers on the electron energy were used to determine the threshold energies for the displacement of atoms in GaAs during formation of the low- and high-temperature defects. These energies were 25 ± 2 and 19 ± 2 eV, respectively. The threshold energies obtained by other authors were analyzed. The rate of removal of carriers during electron bombardment was independent of the orientation. (auth)

19579 INFLUENCE OF THE ANNEALING OF RADIATION DEFECTS ON THE ABSORPTION SPECTRUM OF GALLIUM ARSENIDE IRRADIATED WITH FAST NEUTRONS. Baramidze, N. V.; Kurdiani, N. I. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 4, 555-8(Oct 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 4, 631-5(Apr 1971).

The influence of the isochronous annealing of radiation defects on the absorption spectrum of n-type gallium arsenide irradiated with fast neutrons (7.2×10^{17} cm^{-2} dose) was investigated. The measurements were carried out at 93°K. Annealing in the temperature range 150 to 350°C shifted the absorption spectrum in the direction of higher energies, and at 350°C the spectrum coincided almost completely with the $K(h\nu)$ curve before irradiation. The absorption coefficient $K(h\nu)$ of the irradiated GaAs samples obeyed the exponential law. The isochronous annealing did not alter the nature of the dependence $K(h\nu)$. This was explained by assuming that the incident light was absorbed not by the simple radiation defects but by disordered regions that formed in the neutron-irradiated GaAs crystals. It was concluded that annealing did not dissociate these regions into simple defects but destroyed them completely. A comparison of a disordered region with the amorphous state of a semiconductor indicated that the edges of the allowed energy bands in the disordered region were smeared out. This was responsible for the monotonic nature of the dependence $K(h\nu)$. (auth)

19580 RECOMBINATION CENTERS IN NEUTRON-IRRADIATED GERMANIUM. Atakova, E. M. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 4, 525-7(Oct 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 4, 593-5(Apr 1971).

The concentration of recombination centers N_r and the cross section for the capture of holes by these centers σ_p are estimated for neutron-irradiated germanium from simultaneous measurements of the electrical conductivity of bulk germanium and of the reverse current in germanium diodes during irradiation and annealing. The results show that $\sigma_p \geq 3.4 \times 10^{-13}$ cm^2. (auth)

19581 CALCULATION OF THE AVERAGE NUMBER OF RADIATION DEFECTS IN Si AND SiO_2 IRRADIATED WITH FAST NEUTRONS. Myasnikov, A. A.; Pozdneev, D. B. (Gorky State Univ., USSR). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 5, 862-3(Nov 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 5, 976-8(May 1971).

Calculations of the number of Frenkel defects are reported for Si in the neutron energy range 0.14 to 14 MeV. The results are compared with previous calculations; two peaks, due to resonances, are revealed at 0.576 and 1.65 MeV. Some calculations for SiO_2 at neutron energies of 0.3 to 6 MeV are also reported; a peak is seen at 1 MeV. (D.L.C.)

19582 INTERFERENCE METHOD FOR MEASURING THE EFFECTIVE THICKNESS OF ION-IMPLANTED LAYERS. Gusev, V. M.; Strel'tsov, L. N.; Khaibullin, I. B. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 5, 737-9(Nov 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 5, 832-5(May 1971).

An interference method was developed for measuring the effective thickness of doped layers obtained by the bombardment of silicon and germanium single crystals with phosphorus ions. The conditions were determined under which the interference of light occurred in such layers. Calculation equations were derived for the determination of the refractive index and the effective thickness of a doped layer. A comparison was made between the effective thickness of a doped layer measured by the proposed interference method and by the method of layer-by-layer etching. The error in the measurement of the effective thickness of an ion-implanted layer by the interference method did not exceed 10 to 15%. (auth)

19583 ANNEALING OF DEFECTS AND FORMATION OF DISORDERED REGIONS IN GaAs SUBJECTED TO ELECTRON BOMBARDMENT. Brailovskii, E. Yu.; Brudnyi, V. N. (Inst. of Nuclear Research, Kiev). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 1101-3(Dec 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1248-51(Jun 1971).

Measurements of the electric conductivity and the carrier density and mobility were used to study the introduction and annealing of defects in n-type GaAs single crystals after bombardment by fast electrons (1, 2, 3.5, 10, and 45 MeV). The annealing stages were studied. It was concluded that heating after irradiation with 1- to 10-MeV electrons increased the mobility of point defects, and if their concentration was high, they could coalesce to form disordered regions up to 300°C. Above this temperature, the disordered regions are dissociated. (D.L.C.)

19584 ROLE OF DISLOCATIONS IN ANNEALING OF IRRADIATED GERMANIUM. Smirnov, L. S.; Stas, V. F.; Khainovskaya, V. V. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 1033-7(Dec 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1179-84(Jun 1971).

The effect of dislocations on the annealing of radiation defects in germanium after irradiation with electrons was studied. It was found that dislocations play an important role in the change of carrier density on annealing. The results are explained with a model that takes into account the decay and changes in the structure of complexes in the annealing process, based on the possible existence of barriers against the formation of different complexes and competition for capture of the mobile components of Frenkel pairs. (auth)

19585 INFLUENCE OF NEUTRON IRRADIATION ON THE MOBILITY OF ELECTRONS IN PLASTICALLY DEFORMED InSb CRYSTALS. Katsiashvili, R. G.; Kurdiani, N. I. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 1026-8(Dec 1971). Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1170-3(Jun 1971).

The temperature dependence (77 to 278°K) of the mobility of electrons in plastically deformed indium antimonide was investigated. The mobility increased considerably when such deformed samples were irradiated with fast neutrons. An analysis of the temperature dependences of the mobility indicated that the radiation defects generated by fast neutrons interacted with dislocations to form new complex defects with smaller scattering cross sections. A model of these defects was derived on the assumption that charged dislocations became associated with disordered regions. (auth)

19586 INVESTIGATION OF THE EFFECTS CAUSED BY PRELIMINARY ILLUMINATION OF BORON CRYSTALS. Anisimov, B. B.; Dzhamagidze, Sh. Z.; Shvangiradze, R. R. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 991-3(Dec 1971). Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1126-29(Jun 1971).

Pure coarse-grained samples of β-rhombohedral boron were subjected to a comprehensive investigation at liquid nitrogen temperatures. This investigation included measurements of the electrical conductivity, impurity photoconductivity, and optical absorption, all of which were induced by a preliminary illumination with light corresponding to the fundamental absorption region. The induced photoconductivity increased proportionally to the conductivity during illumination and was not related to the increase in the absorption coefficient in the same part of the spectrum. It was concluded that the preliminary illumination increased considerably the carrier mobility in β-boron. The thermally stimulated current method indicated the presence of a spectrum of trapping levels in zone-refined β-boron; the depths of these levels ranged from 0.1 to 0.32 eV. (auth)

19587 MEASUREMENT OF CARRIER LIFETIME IN NEUTRON-IRRADIATED GERMANIUM AND SILICON. Afanas'ev, V. N.; Stepovik, A. P.; Tuturov, Yu. F.; Filimoncheva, P. I. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 944-8(Dec 1971). Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1067-73(Jun 1971).

It was established experimentally that, after irradiation with 14-MeV neutrons, the lifetime damage constant of germanium and silicon decreases with decrease in temperature. The radiation constant K at 300°K is 1.2×10^6 neutrons · sec · cm^{-2} for silicon and 4×10^6 neutrons · sec · cm^{-2} for germanium, and at 77°K it is 1.0×10^5 and 2.3×10^5 neutrons · sec · cm^{-2} for silicon and germanium, respectively. On the basis of a study of the temperature dependence of the damage constant and the temperature dependence of the lifetime in irradiated samples, it is concluded that the main contribution to the change in the radiation constant with temperature is made by annealing of radiation defects in germanium; in silicon, the main contribution comes from the variation with temperature in the capture cross section of the defects. (auth)

19588 BEHAVIOR OF GERMANIUM IMPLANTED IN GaAs BY ION BOMBARDMENT. Zelevinskaya, V. M.; Kachurin, G. A. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 1011-13(Dec 1971). Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1150-3(Jun 1971).

Gallium arsenide n- and p-type samples of different conductivities were bombarded with 30-keV germanium ions. The ion doses were 10^{13} to 10^{15} cm^{-2}. The properties of the irradiated layers were determined by a system of radiation defects right up to annealing temperatures of 500°C. After annealing at temperatures exceeding 500°C, the implanted germanium ions occupied preferentially the vacant gallium sites. The annealed layers had n-type conduction. The carrier density and mobility in these layers were close to the values typical of gallium arsenide heavily doped with germanium by the conventional methods. No diffusion of germanium out of the irradiated layer was observed up to 700°C, and this made it possible to prepare layers of n-type GaAs whose thickness was less than 500 Å. It was assumed that the absorption of interstitial germanium by the excess vacancies reduced the effective rate of diffusion of germanium in gallium arsenide. (auth)

19589 STIMULATED EMISSION OF INDIUM MONOSELENIDE SUBJECTED TO ELECTRON BOMBARDMENT. Kurbatov, L. N.; Dirochka, A. I.; Britov, A. D.; (and others). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 3, 494-6(Sep 1971). Translated from Fiz. Tekh. Poluprov.; 5: No. 3, 563-5(Mar 1971).

The spontaneous and stimulated radiation emitted by InSe single crystals excited by fast electron pulses at 90°K was observed and investigated. The formation and reactions of excitons are discussed. The effects of raising the temperature to 300°K were also studied for the cathodoluminescence spectrum. The afterglow times of the spontaneous luminescence were determined. (D.L.C.)

19590 INFLUENCE OF NEUTRON AND α-PARTICLE IRRADIATION ON THE NEAR-INFRARED TRANSMISSION SPECTRA OF BORON-DOPED CRYSTALS OF THE 6H MODIFICATION OF α-SiC. Il'in M. A.; Kosaganova, M. G.; Solomatin, V. N.; Barinov, Yu. V.; Bulgakov, Yu. V. (State Scientific-Research and Design Inst. of the Rare-Metal Industry, Moscow). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 3, 443-6(Sep 1971). Translated from Fiz. Tekh. Poluprov.; 5: No. 3, 506-9(Mar 1971).

Crystals of boron-doped hexagonal silicon carbide were irradiated with fast neutrons and 25-MeV α particles. The transmission spectra and the electrical properties were determined before and after irradiation. Irradiation reduced the intensity of a wide absorption band due to boron. Moreover, nonselective absorption appeared near the fundamental edge. Two models were suggested in the interpretation of the nature of the nonselective absorption. (auth)

19591 INFLUENCE OF REAL STRUCTURE ON HARDENING OF ALKALI METAL HALIDE CRYSTALS. Suszynska, Maria Postepy Fiz.; 22: No. 6, 659-78(1971). (In Polish).

Characteristics of structural defects, in particular, in ionic crystals are given. The influence of these defects on mechanical properties of alkali metal halides (AH) is discussed. Based on actual theories, the admixture hardening within the range of solid solutions in AH: Me^{2+} system is deduced. The possibility of applying various methods to the examination of dislocation mobility in both doped and irradiated crystals is shown. (51 references) (auth)

19592 FORMATION OF p–n JUNCTIONS BY IN-PILE RADIATION DOPING. Podsekin, A. K.; Solov'ev, S. P.; Kharchenko, V. A. At. Energ. (USSR); 31: No. 5, 521-2(Nov 1971). (In Russian).

Production of electron–hole junctions at elevated temperatures reduces their useful life because of side effects. A novel alternate process uses slow neutrons to produce n-type phosphorus impurities by the reaction ^{30}Si (n, γ) ^{31}Si which rapidly becomes ^{31}P through β decay. Experiments were carefully designed to study this possibility of attaining the desired p–n junctions. Neutron environment difficulties lead to the conclusions that specialized reactors are necessary, or that a thermal column must be used. (K.S.W.)

19593 EFFECT OF ANNEALING ON DEFECTIVE STRUCTURE OF NEUTRON-IRRADIATED LiF CRYSTALS. Zefirova, V. L.; Kolontsova, E. V.; Telegina, I. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 199: No. 4, 821-3(1 Aug 1971). (In Russian).

LiF monocrystals were irradiated with about 10^{18} neutrons/cm^2 before and after two-hr annealing at 150 to 750°C. The crystals were then examined by diffuse and small-angle x-ray scattering and by the electron microscope. The basic change observed in the diffraction pattern upon annealing was a change in the isotropic scattering and intensity, corresponding to a two-dimensional diffraction {100} both at large and small angles. Isotropic scattering was reduced in intensity at about 450°C, and disappeared completely at temperatures of 600 to 700°C, suggesting "resorption" of equiaxial accumulation of point defects. (K.S.W.)

19594 METHOD FOR THE DETERMINATION OF RECOIL ION RANGES NEEDED IN DSA MEASUREMENTS. Bister, M. (Helsinki Univ. of Tech., Otaniemi, Finland); Anttila, A.; Fonetil, A.; Leminen, E. Z. Phys.; 250: No. 1, 82-6(1972).

From the yield curve of the $^{27}Al(p,\gamma)^{28}Si$ reaction obtained with implanted targets, the range distributions and mean ranges of 50-keV Al^+ ions were determined in C, Cu, Mo, and Ta. The energy straggling of protons was taken into account in the analysis. The DSA lifetime values in different backing materials are in good agreement when measured ranges are used for the determination of the stopping parameters. (auth)

19595 POSITRON-LIFETIME MEASUREMENTS IN POLYMERIZING ORGANIC SOLIDS. Ito, Yasuo; Okuda, Kouji; Tabata, Yoneho (Tokyo Univ.). Bull. Chem. Soc. Jap.; 44: No. 7, 1764-7(Jul 1971).

Measurement of the e^+ lifetime in solid monomers during γ-induced polymerization was carried out. The mechanism of solid-state polymerization can be analyzed by the measurement of the lifetime of positrons and the amounts of positronium formed. This method was applied to the solid-state polymerization of acrylamide. It was found that the lifetime spectrum changes remarkably in the induction period of polymerization. The decrease in the

annihilation rate λ_2 was interpreted in terms of the formation of a larger free volume during polymerization. The intensity of the slow component was also observed to decrease in the induction period of polymerization. The accumulation of active species that capture positrons and the decrease in the number of free volumes were suggested as explanations of the phenomena. (auth)

19596 EXCITATIONS PERTURBED BY SELF-TRAPPED EXCITONS IN ALKALI IODIDE CRYSTALS. Williams, R. T.; Kabler, M. N. (Naval Research Lab., Washington, D. C.). Solid State Commun.; 10: No. 1, 49-51(1 Jan 1972).

A strong transient optical absorption band on the exciton shoulder was observed in pure alkali iodide crystals following pulsed-electron irradiation. The ultraviolet transition is ascribed to creation of a second exciton in the vicinity of a self-trapped exciton. The perturbation caused by the proximity of the self-trapped exciton lowers the energy needed to form the second exciton by 0.14 eV for KI and 0.12 eV for RbI. (auth)

19597 OBSERVATION OF U CENTRES IN PROTON-IRRADIATED KCl. Hughes, A. E.; Pooley, D. (Atomic Energy Research Establishment, Harwell, Eng.). Solid State Commun.; 10: No. 1, 53-5(1 Jan 1972).

Optical and infrared spectra of U centers formed by proton and deuteron irradiation of KCl are reported. The efficiency of formation of U centers is roughly one U center per ten incident protons. U → F conversion by ultraviolet bleaching confirms that the implanted U centers behave in the same way as in chemically doped crystals. (auth)

19598 IRRADIATION EFFECTS IN SiO_2 POLYMORPHS. Revesz, A. G. (Communications Satellite Corp., Clarksburg, Md.). Solid State Commun.; 10: No. 1, 127-30(1 Jan 1972).

Irradiation-induced changes in density and molar refraction of SiO_2 polymorphs as well as saturation effects result from maximizing π-bonding and minimizing bond strain in Si–O ring configurations. Trivalent silicon and nonbridging oxygen defects are generated without significant atomic displacements. Irradiation behavior of SiO_2 is more similar to that of siloxane polymers than typical ionic or covalent crystals. (auth)

19599 CHANNELING STUDIES IN SINGLE CRYSTALS OF CALCIUM FLUORIDE. Hellborg, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Scr.; 3: No. 6, 279-92(1971).

The channeling characteristics of protons and helium ions in a diatomic single crystal (CaF_2) were studied in the energy range 0.67 to 4.00 MeV. The steering properties of each sublattice were measured independently by detecting Rutherford backscattered ions and gamma rays from the nuclear reaction $^{19}F(p,\alpha\gamma)^{16}O$. The critical angle for channeling ($\psi_{\frac{1}{2}}$) and the minimum yield (χ_{min}) were measured and compared to theory. The value of $\psi_{\frac{1}{2}}$ for axial channeling has a functional dependence that agrees well with calculations based on the average potential along the row. The measured critical angles are, however, lower in absolute magnitude than calculated. (auth) (Sweden)

19600 ESR STUDY OF THE LOCAL DEFECTS IN IONIC CRYSTALS. Nistor, S. V. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 9, 1033-74(1971). (In Rumanian).

Color centers in alkali metal halides were studied. ESR of alkali metal halides containing $3d^n$ ions was studied, and energy-level calculations are given for ^6S ions situated in axially deformed crystalline fields. ESR studies of NaCl single crystals doped with Fe, Mn, Ca, and Ni are reported. Some ESR studies of x-irradiated crystals are also given. (D.L.C.)

19601 SPUTTERING OF SILICON AND GERMANIUM BY MEDIUM-ENERGY HEAVY IONS. Sommerfeldt, H.; Mashkova, E. S.; Molchanov, V. A. (Moscow State Univ.). Phys. Lett.; 38A: No. 4, 237-8(14 Feb 1972).

The angular and energy dependences of the sputtering ratios of silicon and germanium targets under bombardment by 14- to 34-keV argon ions are presented. (auth)

19602 KINETICS OF FORMATION OF COLOR CENTERS IN α-QUARTZ. Angerer, R.; Gross, F.; Koss, P. (Univ., Graz. Reaktorzentrum, Seibersdorf, Austria). Acta Phys. Austr.; 33: No. 1, 3-7(1971). (In German)

The origin of the smoky quartz center was investigated at various irradiation temperatures. The color centers were produced by x irradiation at a maximum energy of 50 keV. The optical density and, therewith, the origin of the color centers was measured with a photometer since the extinction in the absorption maximum of the color center concentrations is proportional. The A1 band of the smoky quartz spectrum at 2.0 eV was measured in the maximum. The temperature dependence of the color center formation is explained. The transformation into the smoky quartz centers is described. (J.S.R.)

Physical Properties

Refer also to abstracts 18132, 18239, 18240, 18254, 18283, 18291, 18311, 18317, 19188, and 19205.

19603 (CALT-767-P-11-X-1) STUDY OF DEEP LEVELS IN DETECTOR-GRADE GERMANIUM BY CHARGE TRANSPORT TECHNIQUES. Report No. 1. Caywood, John; Marrello, Vince; Ottaviani, Gianpiero; Mayer, J. W.; Nicolet, M.-A. (California Inst. of Tech., Pasadena. Dept. of Electrical Engineering). 7 Jan 1972. Contract AT(04-3)-767. 8p. Dep. NTIS.

The objective was to develop techniques to evaluate high-purity germanium, using drift-velocity measurements and double-injection studies. Another objective was also to form contacts on high-purity germanium at temperatures sufficiently low so that the material properties would not be degraded during processing. It was found that contacts could be made that exhibited both injection and blocking characteristics by heat treatment of evaporated metal layers at temperatures less than 300°C. (D.L.C.)

19604 (COO-1041-23) ANOMALOUS HALL RESISTIVITY OF MONOCRYSTALLINE GADOLINIUM AND ITS PRESSURE EFFECT. Sawaoka, A.; Tomizuka, C. T. (Arizona Univ., Tucson. Dept. of Physics). [1967]. Contract AT(11-1)-1041. 7p. Dep. NTIS.

Change of Hall resistivity of monocrystalline gadolinium was obtained at 210, 273, and 295°K at pressure up to 6 kb. The absolute value of resistivity decreases with increasing pressure. The decrease was explained qualitatively on a transition of 4f-electron to 5d state. (auth)

19605 (LBL-281) OPTICAL STUDIES OF LANTHANIDE AND ACTINIDE IONS IN CALCIUM FLUORIDE. Stacy, James Joseph (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1971. Contract W-7405-eng-48. 147p. Dep. NTIS. Thesis.

Optical absorption and thermoluminescence measurements were used to study the effects of γ irradiation on trivalent actinide ions in CaF_2. Thermoluminescent glow curves for Np, Pu, Am, and Cm (and, for comparison, the lanthanides Er, Ho, and Tm) were measured between 100 and 300°K. These were found to be remarkably similar, with glow peaks occurring at nearly the same temperatures for each of the ions. The activation energies for each of the glow peaks were estimated. High-resolution measurements of the spectra of the thermoluminescence showed that the emission is identical to the fluorescence of the trivalent ions, and determines the site symmetry of the emitting ion. Evidence was presented that the glow emission below 300°K originates from trivalent actinide ions in cubic sites. In the model proposed to explain these data, irradiation at 77°K produces hole traps and electrons that are localized near cubic Ac^{3+} ions. Heating allows a hole to diffuse to the site of a localized electron. The hole and extra electron recombine, leaving an excited trivalent actinide ion. Decay of this ion to its ground state results in the observed thermoluminescence. When the $Ac^{3+}-CaF_2$ crystals were irradiated at 300°K, the actinide ion was oxidized to the tetravalent state. In the proposed model, heating allows electrons trapped in the lattice to recombine with the Ac^{4+} ions. The decay of the newly formed Ac^{3+} ion to its ground state results in the observed thermoluminescence. The optical Zeeman rotation spectra were taken of some selected transitions in Am^{3+}, Cm^{3+}, and Nd^{3+} embedded in CaF_2. Only symmetry sites arising from tetragonal compensation could be positively identified, although there was evidence for the existence of lower symmetries. This technique is of general applicability to problems of nonequivalent sites and provides a more positive identification than Zeeman studies restricted to a few crystallographic directions. (auth)

19606 (ORNL-tr-2564) CHANGES IN THE MAGNETIC SUSCEPTIBILITY (μ) OF AUSTENITIC STAINLESS STEEL UPON TREATMENT. Fujiwaka, Setsuya (Nagoya Univ. (Japan). Inst. of Plasma Physics). Translated for Oak Ridge National Lab., Tenn., from report IPPJ-DT-20. 23p. Dep. NTIS.

Four commercial stainless steels (SUS-27, 18Cr–8Ni; SUS-32, 18Cr–12Ni; SUS-41, 22Cr–12Ni; and SUS-42, 25Cr–20Ni) were subjected to cold-working (cutting), soldering, welding, and solid-solution treatments. Magnetic flux measurements were made following each treatment. Shear cutting increased the susceptibility μ in SUS-27 and -32, with no effect in SUS-41 and -42. Metal saw cuts produced no effects. An increase in μ was produced by the thermal effects of silver soldering, which was greatest in SUS-42 and -41. Welding gave the order of μ increases as SUS-32, -27, and -41, with no change in SUS-42. Solid-solution treatment and variations in welded sections affected the magnitude of the μ increases. (D.L.C.)

19607 LOW TEMPERATURE HEAT CAPACITY OF SOME RARE EARTH ALUMINUM LAVES PHASE COMPOUNDS: YAl_2, $LaAl_2$, AND $LuAl_2$. Hungsberg, R. E.; Gschneidner, K. A. Jr. (Ames Lab., Iowa). J. Phys. Chem. Solids; 33: No. 2, 401-7 (Feb 1972).

The heat capacity of three rare-earth Laves phase compounds YAl_2, $LaAl_2$, and $LuAl_2$ were measured in the temperature range of 2.5 to 20°K. A superconducting transition was observed in $LaAl_2$ at 3.29°K. The C/T vs T^2 data yielded $\gamma = 1.81$ mJ/g at.-°K^2 and $\theta = 473$°K for YAl_2, $\gamma = 3.65$ mJ/g at.-°K and $\theta = 352$°K for $LaAl_2$, and $\gamma = 1.9$ mJ/g at.-°K^2 and $\theta = 384$°K for $LuAl_2$. The Debye temperatures indicate that the low-temperature lattice dynamics are controlled by the B element (aluminum). The Debye temperature of $LaAl_2$ is anomalously low compared to those of YAl_2 and $LuAl_2$, and the electronic specific constant, γ, of $LaAl_2$ is anomalously high compared to YAl_2 and $LuAl_2$. The high γ value is thought to account for superconductivity in $LaAl_2$ and the absence of superconductivity in the other two Laves phases. It is found that $LaAl_2$ behaves as a BCS superconductor. (auth)

19608 REFLECTION OF ELECTRONS FROM A METAL SURFACE. Dubovskii, L. B. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 1960-6(Feb 1972).
Translated from Fiz. Tverd. Tela; 13: No. 8, 2340-8(Aug 1971).

A study is made of the behavior of a metal under anomalous skin effect conditions with a magnetic field H directed parallel to the surface of the metal. It is shown that the variation of the surface impedance with magnetic field H and frequency ω depends on the form of the reflection coefficient of electrons from the surface q as a function of the angle of incidence φ of electrons upon the surface. It is shown that the functional dependence of the surface impedance on magnetic field and frequency can be used to recover the form of the function $q(\varphi)$. The method described for recovering $q(\varphi)$ is compared with other possible methods. (auth)

19609 NUCLEAR MAGNETIC RESONANCE AND MAGNETIC SUSCEPTIBILITY OF THE INTERMETALLIC COMPOUND $Ce_xY_{1-x}Al_3$. Niculescu, V. (Babes-Bolyai Univ., Cluj); Pop, Iuliu; Rosenberg, M. Rev. Roum. Phys.; 16: No. 10, 1145-8 (1971). (In German).

The temperature dependence of the Knight shift, the NMR line width, and the magnetic susceptibility of $Ce_xY_{1-x}Al_3$ intermetallic compounds were measured. During the partial substitution of Ce with Y atoms, one observes that the mechanism of the s-f exchange interaction between localized 4f electrons and conduction s electrons introduces essentially no modifications. (tr-auth)

19610 RADIATION-CONTROLLED ELECTROLUMINESCENCE IN DOUBLE-BAND ZINC SULPHIDE PHOSPHORS. Prakash, S. G.; Mohan, Hari (Univ. of Allahabad, India). Indian J. Pure Appl. Phys.; 9: No. 10, 807-9(Oct 1971).

X-ray induced enhancement effect was investigated in the electroluminescence of hydrogen coactivated ZnS: Cu double-band phosphors. The two emission peaks (blue and green) typical of the system studied, though developing at different frequencies of the applied electric field, were found to behave rather similarly as regards the enhancement. The enhancement ratio $R = (L_{E+R}/L_E + L_R)$ (where L_E is the electroluminescent brightness; L_R, the luminescent brightness due to x radiation; and L_{E+R}, the brightness due to the joint action of electric field and x radiation) was found to be always less than $\frac{1}{3}$. The relative enhancement of the two peaks was found quite consistent with the order of overlapping of the electroluminescent and photoluminescent bands. No "memory effect" was detected in the enhancement behavior studied through an automatic graphic recorder. (auth)

19611 CRYSTALLOGRAPHIC DISTORTION IN $TbVO_4$ AT 32°K. Will, G. (Univ., Bonn); Gobel, H.; Sampson, C. F.; Forsyth, J. B. Phys. Lett.; 38A: No. 3, 207-8(31 Jan 1972).

X-ray-diffraction measurements on single crystals and powders of $TbVO_4$ have shown that it undergoes a crystallographic transition from tetragonal to orthorhombic below 32°K. The orthorhombic cell is related to the original cell by having its a and b axes along the original ⟨110⟩ directions. The fractional distortion between the a and b axes is 21.7×10^{-3} and the transition appears to be of second order. (auth)

19612 MAGNETIC SUSCEPTIBILITY OF $UC_{1-x}N_x$ FROM 4° TO 1,100°K. Ohmichi, Toshihiko; Nasu, Shoichi; Kikuchi, Takeo (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 11-18(Jan 1972).

The magnetic susceptibility χ of $UC_{1-x}N_x$ was measured in the temperature range 4 to 1100°K. In the case of UN, χ has a maximum at 52°K, characteristic of the antiferro-paramagnetic transition. This peaking of χ is observed up to 50% UC. The Neél temperature T_N does not change significantly with the content of carbon, nor does Curie paramagnetic temperature θ change in the paramagnetic composition region, whereas the magnetic moment n_p decreases markedly and evenly with increasing carbon content. In the case of UC, χ decreases with T^2 at high temperature. This is also observed in paramagnetic $UC_{1-x}N_x$. Further, some anomalies that are not related to the magnetic transition are observed in $\chi-T$ curves of $UC_{1-x}N_x$. These phenomena are explained in terms of the interaction between 7s electrons and localized 5f electrons and of the particular characteristics of the electron bands in these compounds. (auth)

19613 OBSERVATION OF DYNAMICAL EFFECTS IN PARAMAGNETIC RESONANCE OF Eu^{2+} IN Yb METAL. Schmidt, H. K.; Schaefer, W.; Keller, G.; Elschner, B. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett.; 38A: No. 3, 201-2(31 Jan 1972).

Electron-spin-resonance measurements of Eu^{2+} in Yb metal showed that, in this case, the g-shift is almost totally suppressed by dynamical effects. By adding nonmagnetic Ca impurities, the g-shift is increased, revealing a temperature and frequency dependent g-values and line width that can be described by the formulas of Hasegawa. The exchange integral between 4f electrons of the Eu^{2+} ion and the conduction electrons was determined to be $J = +0.09$ eV. (auth)

19614 MAGNETIC PROPERTIES OF THE ACTINIDE METALS. Fournier, J. M. (CEN, Grenoble, France. Centre National de la Recherche Scientifique, Grenoble, France). Ann. Phys. (Paris); 6: No. 3, 159-66(Jun 1971). (In French).

The magnetic properties of the actinide metals are reviewed. The experimental and theoretical results published up to now about the actinides in the metallic state are presented. The nature of paramagnetism is analyzed and the specific magnetic properties of thorium, uranium, plutonium, and to a certain extent neptunium, americium, and curium are emphasized. The evolution of the magnetic properties along the 5f series is studied. (France)

19615 THEORY OF THE ELECTRICAL RESISTANCE OF GRAPHITE. Pospelov, Yu. A. (Moscow Inst. of the National Economy). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 1943-7(Feb 1972).
Translated from Fiz. Tverd. Tela; 13: No. 8, 2319-24(Aug 1971).

Theoretical relations are deduced for the resistance of a graphite film and for the mean carrier mobility as functions of temperature on the basis of the energy dependence of the carrier relaxation time via the effective-mass approximation. These relations agree well with experiment throughout the temperature range for predominantly phonon scattering of carriers ($T \gtrsim 50$°K). Experimental values are used only for the single point $T = 300$°K. (auth)

19616 MAGNETIC SUSCEPTIBILITY STUDY OF COLOR CENTERS IN CeO_2 CRYSTALS WITH Gd IMPURITY IONS. Adamyan, V. E.; Vinokurov, I. V.; Mantashyan, N. A.; Stepanyan, S. V. (Erevan State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 1934-7(Feb 1972).
Translated from Fiz. Tverd. Tela; 13: No. 8, 2309-13(Aug 1971).

The Faraday method was used to measure the magnetic susceptibility temperature dependence in CeO_2 + 0.4 at. % Gd crystals for five different states of reduction over the temperature range 77 to 300°K. It was established that: 1) the absorption and evolution of oxygen by these crystals begins even at 300 to 400°K; 2) the color centers forming during the reduction of CeO_2 are paramagnetic; 3) it is hypothesized that two types of color centers are formed, those with a single and those with two electrons trapped at oxygen vacancies, having effective magnetic moments, respectively, of 1.74 and 2.16 μ_B. The magnetic susceptibility was resolved into temperature-dependent and temperature-independent parts, and it was shown that the temperature-independent fraction of the paramagnetic susceptibility increases with increase in color-center concentration. It was proposed on this basis that there is increased interaction among paramagnetic centers, which agrees with the mechanism of electrical conductivity previously established for this oxide (Soviet Phys. Solid State, 11: 207(1969)). (auth)

19617 KINETIC PROPERTIES AND ELECTRON-PHONON SCATTERING IN TRANSITION METALS. Zinov'ev, V. E.; Gel'd, P. V. (Ural Polytechnic Inst., Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 1897-1900(Feb 1972).
Translated from Fiz. Tverd. Tela; 13: No. 8, 2261-5(Aug 1971).

The thermal diffusivity of yttrium was studied at 750 to 1600°K. The thermal conductivity is also calculated for the same temperature range. As in the case of palladium and platinum (studied earlier), yttrium has a positive temperature coefficient of thermal conductivity at high temperatures. For palladium and platinum, the behavior of the kinetic properties at high temperatures may be explained by considering the scattering of phonons by small groups of carriers (light holes in the first Brillouin zone). Certain

parameters of these groups are calculated, and it is indicated that a similar scattering mechanism may occur in yttrium. (auth)

19618 COLORATION OF LiF CRYSTALS CONTAINING QUASI METAL. Politov, N. G.; Vorozheikina, L. F. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 2, 207(Feb 1971).

Translated from Opt. Spektrosk.; 30: No. 2, 378-9(Feb 1971).

Pure LiF single crystals were irradiated with neutrons (2.6×10^{17} n/cm^2) to produce quasimetallic particles of varying size. The relatively large particles produce an absorption band at 335 nm, while the small particles are responsible for the 305-nm band. The effects of annealing of the irradiated crystals and subsequent gamma irradiation were studied. For the crystal containing large particles, F centers are formed, and the size of the particles also increases, with another band appearing at 390 nm. For the crystal with small particles, gamma irradiation produces an intense F band. Thus, radiation disintegration of the quasimetallic particles (anion vacancy aggregates with trapped electrons) occurs only if the particles are small. (D.L.C.)

19619 EMISSION SPECTRA OF MICROPOROUS GLASSES IRRADIATED WITH GAMMA RAYS; RAMAN SPECTRA OF DEFECTS. Pershina, E. V.; Raskin, Sh. Sh. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 2, 139-40(Feb 1971).

Translated from Opt. Spektrosk.; 30: No. 2, 260-2(Feb 1971).

The characteristic emission of microporous glasses irradiated with gamma rays (in high vacuum) was detected when subjected to the radiation of a low-pressure mercury lamp at 4358, 5460, and 5790 Å or the 6328-Å radiation of a He–Ne laser. This emission is in the form of a broad band with an unstructured maximum. Because it develops only after gamma irradiation, disappears on heating above 300°C, and can be excited over a broad range of frequencies, there is a firm basis for hypothesizing that the emission is not fluorescence but Raman scattering of light on defects formed by the action of the gamma rays. (auth)

19620 THEORY OF THE INELASTIC SCATTERING OF LOW-ENERGY ELECTRONS FROM CRYSTAL SURFACES BY ONE-PHONON PROCESSES. Roundy, V.; Mills, D. L. (Univ. of California, Irvine). Phys. Rev., B; 5: No. 4, 1347-63(15 Feb 1972).

A theoretical discussion is presented of the form of the differential cross section per unit solid angle per unit energy shift for the inelastic scattering by one-phonon processes of low-energy electrons from the surface of a semi-infinite crystal. A number of general features of the cross section are discussed, with particular attention to a comparison with the results obtained from the kinematical theory of the scattering process. A series of numerical studies were also carried out of the dependence of the shape of the energy-loss spectrum on momentum transfer for an electron incident on the (100) surface of a model fcc crystal. For a general value of the momentum transfer, the energy-loss spectrum consists of one or more lines that arise from the scattering off surface modes, and a band that has its origin in scattering produced by bulk modes. The shape of the latter feature, as well as the position of the surface-mode peaks, is found to be quite sensitive to the values of the atomic force constants appropriate to the surface layer. It is suggested that the experimental study of the shape of the loss spectrum will provide a powerful means of probing the frequency spectrum of the atomic vibrations near the surface. (auth)

19621 METAMAGNETISM IN NEPTUNIUM(V) OXALATE. Jones, E. R. Jr.; Stone, J. A. (Savannah River Lab., Aiken, S. C.). J. Chem. Phys.; 56: No. 3, 1343-7(1 Feb 1972).

Magnetic properties of neptunium(V) oxalate, $(NpO_2)_2C_2O_4 \cdot 4H_2O$, were studied from 2.4 to 37.5°K with magnetic-susceptibility measurements using a vibrating-sample magnetometer at applied fields of 50–10,000 Oe; Moessbauer spectra of the 59.54-keV γ ray in ^{237}Np were taken from 4.2 to 80°K. A metamagnetic transition was found at 11.6°K. Below 11.6°K, the magnetization isotherms had the characteristic S shape of metamagnets. Below 8°K, a pronounced hysteresis was observed as the field was reduced from saturation. At 3.15°K, the remanent magnetization at 100 Oe was 96% of the saturation magnetization at 10,000 Oe, and 125 times greater than the magnetization in the low-moment state. The Moessbauer spectra exhibited magnetic hyperfine splitting which was independent of temperature, with $g_\theta \mu_n H_{eff} = 10$ cm/sec; splitting above the transition temperature is attributed to a long paramagnetic relaxation time. (auth)

19622 EVIDENCE FOR THE NEGATIVE WORK FUNCTION ASSOCIATED WITH POSITRONS IN GOLD. Costello, D. G. (Gulf Energy and Environment Inc., San Diego, Calif.); Groce, D. E.; Herring, D. F.; McGowan, J. Wm. Phys. Rev., B; 5: No. 4, 1433-6(15 Feb 1972).

Positrons that have been thermalized in various moderators and coated with ~200-Å gold leave the gold surface with an energy that peaks between 0.75 and 2.90 eV. This energy is thought to be associated with a positron or "negative" work function of gold. (auth)

19623 MAGNETOELASTIC ANOMALY IN GADOLINIUM. Freyne, F. (Univ. of California, Los Angeles). Phys. Rev., B; 5: No. 4, 1327-40(15 Feb 1971).

Magnetoelastic energy considerations are used to explain the occurrence of anomalous dips in the velocity of sound in gadolinium below T_c. A molecular-field treatment gives reasonable quantitative agreement with the elastic-constant experiments of Long, Wazzan, and Stern and the magnetization curve as determined from neutron diffraction. (auth)

19624 PHONON SPECTRA OF SOME TRANSITION METAL CARBIDES FROM A SIMPLE PSEUDOPOTENTIAL APPROACH. Mostoller, M. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 5: No. 4, 1260-5(15 Feb 1972).

It is shown that many of the over-all features of the phonon spectra of transition metal carbides and related compounds can be approximately reproduced by a simple dielectric-response approach which uses Heine–Abarenkov pseudopotentials and free-electron screening, although the model calculations do not show the unusual structure seen in some of these materials. Illustrative applications are made to UC, HfC, TaC, and NbC. (auth)

19625 SELF-CONSISTENT ENERGY BANDS IN VANADIUM AT NORMAL AND REDUCED LATTICE SPACINGS. Papaconstantopoulos, Dimitrios A. (George Mason Coll, Fairfax, Va.); Anderson, James R.; McCaffrey, Joseph W. Phys. Rev., B; 5: No. 4, 1214-21(15 Feb 1972).

Self-consistent energy-band calculations for vanadium were performed by the augmented-plane-wave (APW) method, for different values of the statistical exchange parameter α, at normal and reduced lattice constants. Comparisons were made with Fermi-surface, soft x-ray, photoemission, and electronic specific-heat experiments, and reasonable agreement was found. (auth)

19626 ELECTRON ENERGY LEVELS IN $LaSn_3$. II. RELATIVISTIC CORRECTIONS USING PERTURBATION THEORY. Gray, D. M.; Meisel, L. V. (Watervliet Arsenal, N. Y.). Phys. Rev., B; 5: No. 4, 1308-27(15 Feb 1972).

In a previous paper, electron energy levels in perfectly ordered $LaSn_3$ were calculated nonrelativistically for the equivalent of 64 points in the reciprocal-space lattice using a modified orthogonalized-plane-wave method. Perturbation theory is now used to determine the relativistic corrections. Starting with Dirac's theory of the relativistic spinning electron and following Slater, the final $E(\vec{k})$ is written as $E^0(\vec{k})$ plus mass–velocity, Darwin, and spin–orbit corrections where the $E^0(\vec{k})$ are the nonrelativistic energy levels previously calculated. The mass–velocity and Darwin operators do not affect symmetry and thus involve no mixing between different irreducible single-group representations. These two corrections thus cause only a shift in energy. This shift is calculated by nondegenerate first-order perturbation theory. The spin-orbit operator does affect symmetry so that those nonrelativistic levels associated with two- and three-dimensional single-group representations can split. This splitting is calculated by degenerate first-order perturbation theory. The spin–orbit operator can also mix levels belonging to different irreducible single-group representations providing the nonrelativistic levels are not too widely separated in energy. Perturbation theory has been used to determine this mixing in most of the appropriate cases with particular emphasis given to those levels near the Fermi level. Relativistic $E(\vec{k})$ curves are shown for six directions in $\vec{k}$ space. Using the final $E(\vec{k})$, a Fermi level of −0.50 Ry has been computed. This is about 0.03 Ry lower than the nonrelativistic Fermi level. Comparison with the limited amount of existent $LaSn_3$ experimental data is discussed briefly. (auth)

19627 ELECTRON ENERGY LEVELS IN $LaSn_3$. I. NONRELATIVISTIC MODIFIED ORTHOGONALIZED-PLANE-WAVE CALCULATION. Gray, D. M.; Meisel, L. V. (Watervliet Arsenal, N. Y.). Phys. Rev., B; 5: No. 4, 1299-1308(15 Feb 1972).

Electron energy levels in perfectly ordered $LaSn_3$ have been calculated nonrelativistically for the equivalent of 64 points in the reciprocal-space lattice using a modified orthogonalized-plane-wave method (MOPW). A muffin-tin model potential, constructed from the self-consistent nonrelativistic atomic potentials of Herman and Skillman, is used. The crystal calculation is not self-consistent. $E(\vec{k})$ curves are shown for six directions in $\vec{k}$ space. The nonrelativistic Fermi level has been computed to be −0.47 Ry. Calculations were also carried out for a limited number of points using a potential constructed from the self-consistent relativistic atomic potentials of Liberman. Dif-

ferences between the levels resulting from this potential and the levels resulting from the Herman–Skillman-based potential are discussed. (auth)

19628 REDICTION OF A POSSIBLE NEW INTERMEDIATE SPIN ORDERING IN HOLMIUM. Sherrington, D. (Imperial Coll. of Science and Tech., London). Phys. Rev. Lett.; 28: No. 6, 364-7(7 Feb 1972).

Holmium exists in low-temperature conical and intermediate-temperature spiral magnetic phases, implying a temperature-dependent variation of effective anisotropy. It is shown that, if this anisotropy is varied from the spiral to the conical region, there will first be a second-order transition to an intermediate phase whose order is essentially a tilted spiral and then a first-order transition to the cone. The intermediate phase might be found at around 20°K. (auth)

19629 VACANCY-FORMATION ENERGIES IN METALS FROM POSITRON ANNIHILATION. McKee, B. T. A.; Triftshaeuser, W.; Stewart, A. T. (Queen's Univ., Kingston, Ont.). Phys. Rev. Lett.; 28: No. 6, 358-60(7 Feb 1972).

The trapping of positrons at vacancy sites in some metals provides a new and sensitive method for the equilibrium determination of vacancy-formation energies. Data are presented for Al, Cd, In, Pb, and Zn and fitted to a model allowing presentation in the form of Arrhenius plots. The vacancy concentration is not determined because it appears as a product with the positron trapping rate. (auth)

19630 ELECTRONIC PHASE TRANSITION IN $Ce_{1-x}La_x$ ALLOYS. Ramírez, Ricardo (Univ. Catolica de Chile, Santiago); Kiwi, Miguel. Phys. Rev. Lett.; 28: No. 6, 344-6(7 Feb 1972).

Electronic phase transitions in $Ce_{1-x}La_x$ alloys are investigated on the basis of the model recently proposed by Ramírez and Falicov. The influence of the La 4f level is analyzed, and implications on the behavior of pure La are discussed. (auth)

19631 MAGNETIC BEHAVIOR OF USe AT LOW TEMPERATURE. Suski, W.; Rao, V. U. S.; Troc, R.; Wallace, W. E. (Univ. of Pittsburgh). J. Solid State Chem.; 4: No. 2, 223-5 (Mar 1972).

The magnetization versus temperature behavior of USe was investigated in the temperature range from 2.8 to 300°K and in various applied fields up to 21 kOe. A sharp decrease in magnetization was found at low temperatures. This behavior seems to be associated with the rhombohedral distortion in crystal structure, giving rise to a high-anisotropy field below the Curie temperature. Large magnetic-hysteresis effects at low temperatures confirm these arguments. (auth)

19632 MAGNETIC PROPERTIES OF THE EQUIATOMIC RARE EARTH RHODIUM COMPOUNDS TRh (T = Tb, Dy, Ho, Er). Chamard-Bois, R. (CEN, Grenoble, France); Nguyen Van Nhung; Pierre, J. Phys. Status Solidi (b); 49: No. 1, 161-6(1 Jan 1972). (In French).

TbRh and DyRh equiatomic compounds order ferromagnetically, while HoRh and ErRh become antiferromagnets with ordering modes of (ll00) type. The moment values in ordered range are reduced, in agreement with results of crystalline-field calculations. (auth)

19633 RAMAN AND INFRARED MEASUREMENTS AND THE STUDY OF PHASE TRANSITIONS IN $DyVO_4$. D'Ambrogio, F.; Brueesch, P.; Kalbfleisch, H. (Brown Boveri Research Center, Baden, Switzerland). Phys. Status Solidi (b); 49: No. 1, 117-24 (1 Jan 1972).

The observed Raman and infrared active lattice vibrations of $DyVO_4$ are calculated using a valence force field for the internal vibrations of the VO_4 complexes and a central-force field for the external vibrations. On this basis, the degree of coupling between internal and external lattice modes is calculated and found to be small for most of the modes. In addition, the frequencies for the low-temperature orthorhombic structure below 13.8°K are calculated by adopting a slightly modified force field with the appropriate symmetry. The effect of such an orthorhombic deformation is very small for the nondegenerate frequencies, but yields splittings of the degenerate frequencies of the order of 10 cm^{-1}. These predictions are in agreement with the observations. (auth)

19634 ADSORPTION OF TUNGSTEN VAPOR ON SEMICONDUCTOR OXIDES. Tabatadze, D. G.; Myasnikov, I. A. (Physical-Chemical Inst., Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 7, 1050-1(Jul 1971).

Translated from Zh. Fiz. Khim.; 45: No. 7, 1841-2(Jul 1971).

The effect of the adsorption of tungsten vapor on the electrical conductivity and electron work function of thin polycrystalline films of oxide n-type semiconductors was investigated. The adsorption of tungsten vapor on such semiconductors leads to an increase of their conductivity and to a proportional decrease of the electron work function. (auth)

19635 PLASMAS IN SOLIDS. Glicksman, Maurice (Brown Univ., Providence). Solid State Phys.; 26: 275-427(1971).

A review is presented of the behavior and theoretical treatment of solids containing a collection of charges that satisfy the definition of a plasma. After a definition of plasma and a consideration of immobile and mobile plasmas, various methods for production of plasmas are discussed, including irradiation. Plasma properties and instabilities are next considered. (760 references) (D.L.C.)

19636 INTERMAG CONFERENCE, DENVER, COLORADO, APRIL 13–16, 1971. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 325-808(Sep 1971). (CONF-710446).

Included here are 118 papers and 57 "digests" from the total of 214 papers presented at the conference. Separate abstracts were prepared for 11 papers and one "digest". (D.L.C.)

For abstracts of individual papers see: 18239, 18240, and 19637–19646.

19637 MAGNETIC CIRCULAR DICHROISM OF EuO FILMS. Ferre, Jacques (CNRS, Paris); Badoz, Jacques P.; Paparoditis, C.; Suryanarayanan, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 388-91(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

A report is made on the magnetic circular dichroism (MCD) spectra of EuO thin films having a [200] preferential growth, for 6°K < T < 300°K under low or high magnetic fields, according to the spectral range investigated. A tentative interpretation of the temperature dependence of the spectra is proposed. Zero-field spectra were obtained after previous magnetization of the sample below T_c; this provides a new method to determine T_c in zero field. (auth)

19638 ORIGIN OF MAGNETIC HARDNESS IN SPUTTERED THIN FILMS OF Co–V. Johansen, T. R. (UNIVAC, St. Paul); Speliotis, D. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 416-17(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

The temperature dependence of the coercivity and the rotational hysteresis integral of sputtered Co–V thin (180 Å) and thick (900 to 2000 Å) films were studied. The V content was varied from 0 to 12%. The room-temperature coercivity ranged from 65 Oe for thick pure Co to 275 Oe for thin 6% V films. The coercivity ratio H_c (−196°C)/H_c (0°C) was 1.6 for thin films, independent of V content, and 1.37 to 2.25 for thick 12 and 0% V films, respectively. The role of the crystalline anisotropy in the magnetic reversal behavior is examined. The temperature dependence of the coercivity of the films suggests the presence of multidomain crystallites in thick pure Co. The results support the single-domain particle, incoherent rotation model for the thin alloyed films. (D.L.C.)

19639 COERCIVITY OF HEAT-TREATED Pr–Co POWDER COMPACTS. Schweizer, J.; Strnat, Karl J.; Tsui, James B. Y. (Univ. of Dayton, Ohio). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 429-31(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

The variation of coercivity as a function of the temperature of annealing or sintering is reported for compacts of a single-phase $PrCo_5$ powder and also for a mixture of $PrCo_5$ with an additive richer in Pr. For single-phase $PrCo_5$, the intrinsic coercive force decreases steadily with increasing heat-treating temperature and shows a minor peak near 1000°C. For magnets made with the additive, the curve of $_MH_c$ versus T has two peaks, one at approximately 1050°C and another at 1120°C. This behavior can be correlated with thermal events in the Pr–Co phase diagram. It is interpreted in terms of a model which assumes that pinning sites for the domain walls exist and are concentrated in shells forming on the surface of $PrCo_5$ grains during the sintering. These shells are thought to consist of Pr–Co compounds having lower melting points than $PrCo_5$ and to be epitaxial layers on or between the $PrCo_5$ grains into which the walls can travel from the latter. (auth)

19640 INFLUENCE OF SINTERING TEMPERATURE ON MAGNETIC PROPERTIES OF SAMARIUM–COBALT MAGNETS. Das, Dilip K. (Raytheon Co., Waltham, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 432-5(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

Varying the sintering temperature over a narrow range can produce great variations in properties of high-quality permanent magnets of Sm–Co. One particular Sm–Co alloy was chosen for this study. Sintering temperature was varied, while all other processing parameters remained constant. Hysteresis measurements were then carried out in an 100-kOe air-core magnet using a vibrating-sample magnetometer. It was observed that high-per-

formance magnets could be obtained only within a narrow range of temperature, with precipitous drops in quality on both sides of the range. Within this narrow range, systematic and significant variations of some intrinsic properties were also observed. (auth)

19641 EFFECTS OF VARIOUS STRESSES ON MUMETAL: 77 PERCENT Ni–14 PERCENT Fe–5 PERCENT Cu–4 PERCENT Mo. Preece, I. (Univ. of Wales, Cardiff); Thomas, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 554-7 (Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

The effects of stress upon the magnetic properties of Mumetal were studied in detail. The longitudinal Kerr effect was used to study the domain patterns and the transverse Kerr effect used to obtain surface B–H loops characteristic of the material. Bulk measurements were obtained by making standard bridge measurements of initial permeability. The effect of grinding was studied using toroidal samples of thicknesses from 300 to 1620 μm. A possible method of estimating the depth of damage due to grinding by (a) obtaining surface B–H loops as layers of material after chemical removal, and (b) "skin effect" testing was considered. The effect of simple tension on initial permeability was examined for material with negative (–20 J/m^3), zero, and positive (+10 J/m^3) values of anisotropy constant K_1. (auth)

19642 INTERPRETATION OF HYSTERESIS LOOPS OF COBALT–RARE-EARTH SINGLE PARTICLES. Becker, Joseph J. (General Electric Research and Development Center, Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 644-7(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

The magnetic behavior of single particles of Co_5Sm was studied in an effort to understand the origin of the coercive force in cobalt rare earths. It was found that the complex hysteresis loops often observed, containing several magnetization discontinuities, can be analyzed as the linear sum of single-discontinuity hysteresis loop, implying that particle regions can act magnetically independent. (auth)

19643 NUCLEATION AND GROWTH OF MAGNETIC DOMAINS IN SMALL RCo_5 PARTICLES. Bachmann, Kurt (Brown Boveri Research Center, Baden, Switzerland). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 647-50(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

In order to investigate the magnetization process in hard-magnetic RCo_5 compounds (where R = Y, Ce, Pr, and Sm), the magnetic domain structures of $SmCo_5$ and YCo_5 particles were studied in the demagnetized state and in different magnetized states in an external magnetic field. The domains in small (10 to 100 μm) RCo_5 particles were revealed using the magneto-optic Kerr technique. The observed domain structure is typical for a hexagonal material showing high crystalline anisotropy and having its direction of easy magnetization parallel to the c axis. Demagnetized particles even as small as 10 μm consist of a few domains. The demagnetization process of an initially fully magnetized particle thus proceeds by nucleation and subsequent growth of domains of reversed magnetization. The nucleation and growth of reverse domains in $SmCo_5$ and YCo_5 particles under the action of an external magnetic field were observed. (auth)

19644 HIGH-PERFORMANCE MAGNETS OF RARE-EARTH INTERMETALLICS DUE TO AN UNUSUAL MAGNETIZATION PROCESS. Barbara, Bernard (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France); Becle, Christian; Lemaire, Remy; Paccard, Dominique. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 654-6(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

Due to the crystalline field, the rare-earth atoms in low symmetry may show a high magnetic anisotropy. In such materials, especially in Dy_3Al_2 and $TbNi_{1-x}Cu_x$ ($0 < x < 0.4$), because of the high anisotropy, the energy of narrow walls can be smaller than that of Bloch walls. Such narrow walls are frozen as long as the applied field is smaller than a critical field approximately equal to the coercive field. The coexistence of a large remanent magnetization and a large coercive field associated with this new type of domain wall suggests that such materials may be highly feasible for permanent magnets. (auth)

19645 MAGNETIC BEHAVIOR OF RARE-EARTH IRON-RICH INTERMETALLIC COMPOUNDS. Givord, Dominique (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France); Lemaire, Remy; James, William J.; Moreau, Jean-Michel; Shah, Jayant S. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 657-9(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

The thermal variation of lattice parameters of rare earth–transition metal intermetallic compounds rich in Fe, Co, or Ni in the temperature range of 25 to 900°K was studied. For the Fe compounds, negative thermal expansion was observed below their magnetic-ordering temperatures, regardless of the nature of substitutional ordering. For Co and Ni compounds, the thermal expansion behavior was normal. It was then concluded that, for the Fe compounds, the magnetic properties are mainly determined by the Fe–Fe interatomic distances and the number of Fe nearest neighbors, whereas for Co and Ni compounds, the magnetic properties are determined by the conduction-electron transfer from the rare earth to the 3d band of Co or Ni. The anomalous thermal expansion of Fe compounds and the metamagnetic transition of the Lu compound are explained in terms of the distance dependence of the interaction energy as proposed by Néel. (auth)

19646 PERMEABILITY–FREQUENCY RESPONSE OF 4–79 MOLYBDENUM PERMALLOY FOILS. Thornley, Richard F. M.; Kehr, William D. (IBM Corp., Boulder, Colo.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-7: No. 3, 672-5(Sep 1971).

From INTERMAG conference; Denver, Colo. (13 Apr 1971).

Foils of 4–79 molybdenum Permalloy have been measured for permeability–frequency characteristics as a function of heat treatment and foil thickness for frequencies up to 30 MHz. The slope of the permeability–frequency curve was found to be –0.7 instead of the –0.5 expected from classical theory. The low-frequency permeability of foils thinner than 0.5 mil decreases rapidly with decreasing thickness. This decrease may be connected with changes in texture, surface roughness, or grain size, all of which were observed. (auth)

19647 MAGNETIC RESONANCE IN SINGLE-CRYSTAL DYSPROSIUM AT 100 GHz. Wagner, T. K.; Stanford, J. L. (Iowa State Univ., Ames). Phys. Rev., B; 5: No. 5, 1876-8(1 Mar 1972).

The microwave absorption of a single crystal of dysprosium at 100 GHz was studied as a function of temperature and magnetic field applied in the magnetically hard $\langle 10\bar{1}0 \rangle$ direction. A peak in the absorption is attributed to ferromagnetic resonance, and the temperature dependence of the field value at which the resonance occurs is compared with previous theories. The results provide what is believed to be the first unambiguous evidence that magneto-elastic effects are important in the spin-wave spectrum of dysprosium at high microwave frequencies. The best fit between experiment and theory requires a value of the c-axis anisotropy constant less than half that derived from static measurements: i.e., $-2P_2S = 21.6$ K/atom, rather than 50.4 K/atom. The value of the magneto-elastic coupling constant that gave the best fit was $D^\gamma = 1.4$ K/atom, comparable to the static value of 1.1 K/atom. (auth)

19648 LOW-TEMPERATURE HEAT CAPACITY OF $LaPt_2$ AND $CePt_2$ AND THE MAGNETIC SUSCEPTIBILITY OF $CePt_2$. Joseph, R. R.; Gschneidner, K. A. Jr.; Hungsberg, R. E. (Iowa State Univ., Ames). Phys. Rev., B; 5: No. 5, 1878-85(1 Mar 1972).

The heat capacity of $LaPt_2$ and $CePt_2$ was measured from 1.3 to 9°K and the magnetic susceptibility of $CePt_2$ from 1.3 to 80°K. $LaPt_2$ behaves as a normal metal, with $\gamma = 1.17$ mJ/g atom°K^2 and $\Theta_D = 236$°K. $CePt_2$ orders antiferromagnetically at (1.6 ± 0.1)°K. The magnetic-susceptibility behavior and the entropy of ordering can be explained on the basis of a crystal-field splitting of the $J = 5/2$ multiplet into a ground-state doublet and an excited quartet lying 216°K above the doublet. (auth)

19649 MAGNETIC SUSCEPTIBILITY OF α-PLUTONIUM. Blaise, Alain; Fournier, Jean-Marc (CEN, Grenoble, France. Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). Solid State Commun.; 10: No. 1, 141-4(1 Jan 1972).

The magnetic susceptibility of very pure α-plutonium metal was measured between 4.6 and 300°K. At temperatures higher than 80°K, χ is found to be constant. But at lower temperatures, χ goes through a minimum near 40°K. Below 40°K, the data are used to fit a model: $\chi = \chi_0 + C/T - \theta_p$. In view of the results it is felt that an electronic transition occurs around 60°K, due to 5f electrons being condensed and giving rise to localized moments. They appear to be disordered down to 4.6°K. (auth)

19650 NEW PERMANENT-MAGNET ALLOYS OF COBALT AND RARE-EARTH METALS. Schuchert, H. Tech. Mitt. Krupp, Forschungsber.; 28: No. 3-4, 121-6(Dec 1970). (In German).

The development over the last ten years of a group of intermetallic permanent-magnet alloys based on the rare earth metals and Co is discussed. As examples the Gd–Co phase diagram is shown, the crystal structure of RCo_5 is described, and coercivity and anisotropic field-strength values of Co–rare earth alloys are listed. The high anisotropic field strengths, due to crystal anisotropy, result in excellent permanent-magnet properties. Produc-

tion techniques are briefly reviewed and it was concluded that the powder metallurgical process gives optimum magnetic values. (Metals Abstr.)

19651 ANISOTROPIC BEHAVIOR OF DILUTE Au:Dy ALLOYS: OBSERVATION OF THE Γ_8 (QUARTET) RESONANCE. Davidov, D.; Orbach, R.; Rettori, C.; Tao, L. J.; Chock, E. P. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 28: No. 8, 490-3 (21 Feb 1972).

The first observation of a Γ_8 (quartet) resonance in a metal (Au:Dy) is reported. The field for resonance determines the relative magnitude and sign of the crystal-field parameters, $B_4/B_6 = 1300 \pm 30$, to be compared with that found for Ag:Dy alloys, ≤ 340. The line-width yields an exchange-coupling parameter $J_{fs} = 0.14 \pm 0.05$ eV, slightly larger than for Au:Gd and Au:Er alloys, and slightly smaller than for silver-based alloys. (auth)

19652 PURITY AND PERFECTION OF TUNGSTEN SINGLE CRYSTALS. Pikunov, M. V.; Shishkov, V. V. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 189-95 (1971). (In Russian).

The correspondence of calculated and experimental data on the purification of W by electronic crucibleless zone melting to remove Fe, Cr, Mo, and V is established. A difference in hardness on the surfaces corresponding to various crystallographic planes is detected, the values of hardness on the section changing as a function of orientation of the diagonals of the imprint relative to the crystallographic axis. 28 references. (JPRS)

19653 COMPLEX ALLOYING OF MAGNICO WITH SILICON, LANTHANUM, AND BORON. Chernov, V. N.; Larina, L. S. Liteinoe Proizvod.; No. 6, 30-1(Jun 1971). (In Russian).

The effects of Si, La, and B on the magnetic properties of Magnico (Fe-Co-Ni-Al-Cu) were studied. On adding Si up to 0.6% the coercive force and residual magnetization increased; on exceeding 0.7% they fell. On adding B and Si together the coercive force fell with increasing Si content, while the residual magnetization rose more sharply than before. On adding La the effects were more complicated, several maxima and minima appearing on the curve relating the magnetic properties to La content. Reasons for these effects are discussed. (Metals Abstr.)

19654 ELECTRICAL PROPERTIES OF ANODIC OXIDE FILMS OF Ta, Nb, Zr, Ti, W, AND V FORMED BY THE ION-CATHODE METHOD. Husted, D.; Gruss, L.; Mackus, T. (Frankford Arsenal, Philadelphia). J. Electrochem. Soc.; 118: No. 12, 1989-92(Dec 1971).

Amorphous oxide films were grown on Zr, Ti, W, Ta, Nb, and V by ionized gas anodization using the ion cathode as a source of negative ions. Films were grown on each metal at constant current to 175 V, followed by constant voltage for about 4 hr. Several electrical and optical properties were measured for the anodic films produced on these refractory metals. Resistivities of the anodic oxide films on Zr, Ti, W, Ta, Nb, and V ranged from 10^{14} to 10^{17} ohm-cm. Breakdown voltages with the refractory metal positive (gold contact negative) were of the order of 31 V to 111 V. Film capacitances for these metals varied between 0.031 and 0.050 $\mu f/cm^2$, and the dissipation factors averaged 0.015 for all the oxides except V which was 0.062. Thicknesses and refractive indices were obtained by ellipsometry for anodic films on Ta and Nb. Film thicknesses were, respectively, 0.61 and 0.57μ for Ta and Nb, whereas the refractive indices were 2.1 and 2.0. Dielectric constants calculated from capacitance measurements for these anodic films were 22 and 28, respectively. The properties of films prepared by the ion-cathode method are compared with those produced by plasma and solution methods reported by others. (auth)

19655 KONDO EFFECT OF A MAGNETIC IMPURITY UNDER THE CRYSTALLINE FIELD: THE COQBLIN-SCHRIEFFER EXCHANGE INTERACTION. Soda, Toshio (Univ., Frankfurt am Main. Tokyo Univ.). Phys. Kondens. Mater.; 13: No. 3, 246-67(1971).

Using the Coqblin-Schrieffer exchange interaction, the Kondo effect was investigated for a magnetic impurity under the crystalline field, as occurring in La or Y alloys containing cerium impurities. The Hamann type t-matrix equation for the conduction electron scattered by a magnetic impurity is derived and solved, using the method of Zittarz and Mueller-Hartmann. A Kondo-type anomaly and a decreased Kondo temperature due to the crystalline field splittings are found. The resistivity, entropy, and specific heat are calculated, and they show some characteristic behavior due to the crystalline-field splittings. (auth)

19656 DETERMINATION OF RESONANCE AMPLITUDES FOR A THEORY OF CRYSTALLINE FIELD PARAMETERS IN HEAVY RARE EARTH METALS. Dixon, J. M. (Univ. of Warwick, Coventry, Eng.). Phys. Kondens. Mater.; 14: No. 1, 1-6 (1971).

An account is given of a variational calculation to estimate the amplitudes of resonance factors ϵ in a recent theory to describe the enhancement of crystalline-field potentials by conduction electrons in heavy rare-earth metals. It is demonstrated that the values of ϵ obtained by minimizing the energy of interaction between conduction electrons and rare earth ions are consistent with those previously used to form a comparison with experiment. These latter values were obtained by maximizing the A_4^3 crystal field coefficient with respect to ϵ. Consistency is exhibited in both the sign and order of magnitude of the resonance amplitudes and renders the theory parameterless. The values of ϵ show an approximate linear dependence with the number of electrons in the incomplete f shell of the rare-earth ions. (auth)

19657 ADDITIONAL CRYSTALLINE ELECTRIC FIELD POTENTIALS FOR HEAVY RARE EARTH METALS. Dixon, J. M. (Univ. of Warwick, Coventry, Eng.). Phys. Kondens. Mater.; 14: No. 1, 7-14(1971).

A derivation is given of additional crystalline potential energy terms due to the interaction of conduction electrons with the localized electrons of ions in pure heavy rare earth metals. Explicit expressions for the A_4^3 and A_6^3 coefficients are given to supplement those of A_4^3 and A_6^3 given in a recent paper. Additional contributions which arise from the unfilled f shells of the neighbors of any particular ion under consideration, are derived but shown to be of such a magnitude that, for most purposes, they can be neglected. The use of Slater orbitals in calculating enhancement factors for A_4^3 and A_6^3 is discussed, with particular reference to those contributions that involve resonance amplitudes and mainly involve the f orbitals. (auth)

19658 X-RAY INVESTIGATION OF THE LATTICE TRANSFORMATION IN SINGLE CRYSTAL Nb_3Sn. Vieland, L. J. (Radio Corporation of America Labs., Princeton, N. J.). J. Phys. Chem. Solids; 33: No. 3, 581-8(Mar 1972).

Evidence is presented which supports theoretical predictions of a volumeless first-order lattice transformation in Nb_3Sn, with a spontaneous tetragonal strain at T_M in agreement with theory. Below T_M, the crystal gradually converts to a tetragonal domain structure. The orientation of the domains is largely explicable in terms of the general theory of martensitic transformations. (auth)

19659 GROWTH AND ELECTRICAL PROPERTIES OF V_nO_{2n-1} (n = 3, 4, ..., 8) SINGLE CRYSTALS. Nagasawa, Koichi; Bando, Yoshichika; Takada, Toshio (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 5, 322-41(Sep 1971).

Single crystals of the intermediate vanadium oxides between V_2O_3 and VO_2 with the general formula V_nO_{2n-1} (n = 3, 4, ..., 8) were grown by the chemical transport reaction using $TeCl_4$ as a transport agent. The reactions were carried out in sealed tubes. The sizes of the crystals produced were about 1 to 10 mm. The temperature dependence of magnetic susceptibility, electrical resistivity, and thermoelectric power was measured on single crystals. V_3O_5 having monoclinic structure was n-type semiconductor at the temperature ranging from 130°K to room temperature. On V_4O_7, V_5O_9, V_6O_{11}, and V_8O_{15} having triclinic structure, metal-semiconductor transitions occurred at 250, 135, 177, and 70°K, respectively. These transition temperatures were coincident with those of the anomaly in magnetic susceptibility. V_7O_{13} having triclinic structure showed metallic conduction below room temperature. (auth)

19660 PHONON FREQUENCY DISTRIBUTION FUNCTIONS OF COPPER, NICKEL, AND VANADIUM. Prakash, Jai; Semwal, B. S.; Sharma, P. K. (Univ. of Allahabad, India). Acta Phys. Acad. Sci. Hung.; 30: No. 3, 231-40(1971).

The frequency distribution functions of phonons in copper, nickel, and vanadium were determined by a root-sampling technique using Bhatia and Horton's model of the electron-ion interaction. Results are compared with curves obtained from inelastic neutron scattering experiments and other theoretical calculations. The calculated distribution for copper agrees in its broad features with the experimental spectrum of Svenson et al. obtained by the neutron-scattering method. In the case of nickel, a reasonably satisfactory agreement is obtained with the frequency distribution measured by Mozer et al. in incoherent neutron-scattering experiments. For vanadium, the present as well as other theoretical calculations show considerable discrepancies with experiment. The lattice specific heats and the equivalent Debye temperatures obtained from the calculated frequency distributions agree reasonably well with the experimental data for copper and nickel, but not in the case of vanadium. (auth)

19661 EQUALITY OF DIAGONAL AND NONDIAGONAL MICROWAVE SUSCEPTIBILITIES OF EuO. Scheller, S.

(Technische Hochschule, Darmstadt, Ger.). Phys. Kondens. Mater.; 13: No. 3, 187-92(1971).

The two elements χ'_{yx} and χ''_{xx} of the magnetic susceptibility tensor for the cubic ferromagnetic EuO are investigated at microwave frequencies. It is shown that these two elements coincide when the magnetic field is large enough to remove the domain structure within the sample. This is in coincidence with theoretical predictions and shows a certain structure of the Hamiltonian. The magnetic transition temperature is found to be T_c = (69.2 ± 0.2)°K in agreement with the result from specific measurement. (auth)

19662 MEASUREMENT OF THE LOCAL MAGNETIC FIELD AT THE SITE OF Sm IN Sm_6Mn_{23} BY THE SPIN PRECESSION METHOD. Richter, F. W.; Schuett, J. (Univ., Marburg, Ger.). Z. Naturforsch.; 26a: No. 10, 1563-6(Oct 1971). (In German).

The magnetic field at the site of the nuclei ^{152}Sm and ^{154}Sm in a ferrimagnetic Sm_6Mn_{23} probe was measured by means of the perturbed angular correlation method after Coulomb excitation. The temperature dependence of the magnetic field was investigated and compared with the results of macroscopic experiments. It can be concluded that the magnetic field $H_{eff}(T)$ at the site of the Sm nuclei is proportional to the macroscopic magnetization J(T). A ferrimagnetic Curie Temperature of T_C = 438(5)°K was obtained in good agreement with macroscopic values and $H_{eff}(T = 0°K)$ = 1300(50) kOe. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 19040 and 19435.

19663 MECHANISM OF FORMATION OF ANOMALOUS CHARGE STATES OF IRON AFTER ^{57}Co ELECTRON CAPTURE IN Co COMPLEXES. Friedt, J. M.; Baggio Saitovitch, E.; Danon, J. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 16: No. 14, 201-7(1970).

The Moessbauer absorption spectra of ferric acetylacetonate irradiated with 2-MeV electrons are found to be similar to the emission spectra after electron capture in ^{57}Co-labelled $Co(AcAc)_3$. This result indicates that an autoradiolysis mechanism is responsible in molecular compounds for the stabilization of the anomalous iron charge states. (auth)

19664 DYNAMICAL THEORY OF MOESSBAUER DIFFRACTION IN MAGNETICALLY ORDERED CRYSTALS. Belyakov, V. A. Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 1824-32(Feb 1972).

Translated from Fiz. Tverd. Tela; 13: No. 8, 2170-80(Aug 1971).

The diffraction of Moessbauer radiation in magnetically ordered crystals containing Moessbauer nuclei is considered in the two-wave approximation. Equations for the intrinsic polarizations of the γ quanta satisfying the Bragg criterion in a crystal containing anisotropic scattering regions are presented and analyzed on the basis of the dynamical theory. The effect of interference between the nuclear and Rayleigh scattering of the γ quanta on the polarization of the eigenwaves is considered. A solution is obtained for the equations of the dynamical theory of Moessbauer diffraction in the case of the well-resolved Zeeman splitting of the Moessbauer line in a ferromagnetic crystal, first considering nuclear scattering only, and then considering the limiting cases of small and large amplitudes of the nuclear scattering relative to the amplitude of the Rayleigh scattering. The effect of the suppression of the inelastic channels in the interaction of the Moessbauer γ quanta with the crystal on satisfying the Bragg condition is discussed. (auth)

19665 SPIN-LATTICE RELAXATION IN METAL–HYDROGEN SYSTEMS DUE TO CONDUCTION ELECTRONS. Khodosov, E. F.; Shepilov, N. A. (Physical-Technical Inst., Donetsk, USSR). Phys. Status Solidi (b); 49: No. 1, K83-5(1 Jan 1972).

A study was made of the electron contribution T_{1e} to the spin–lattice relaxation time in the region of the rigid lattice, at 77 to 300°K. The hydrides of the following metals and alloys were studied: Y, Ti, Zr, Zr–0.5% Y, Zr–1.5 or 0.5% Nb, and Zr–Ti over the entire composition range. A superfine interaction ($T_{1e}T$ = constant) between the conduction electrons and the proton spins occurs, which increases with hydrogen concentration in Ti–H and decreases in Zr–H and Hf–H. The high-Zr alloys have higher T_{1e} values compared with pure Zr. In the Ti–Zr–H system, electron nuclear interaction mechanisms occur. (D.L.C.)

19666 INFLUENCE OF ESR ON THE HYPERFINE STRUCTURE OF THE MOESSBAUER SPECTRA. Bersuker, I. B.; Borshch, S. A. (Academy of Sciences, Kishinev, USSR). Phys. Status Solidi (b); 49: No. 1, K71-3(1 Jan 1972).

A simple, straightforward method is proposed for changing the directed Moessbauer spectra hfs by means of an additional rf radiation, leading to ESR transitions in the electronic subsystem. The influence of the transitions on the spectral shape through the change of the fluctuating-field dynamics is shown. The ESR radiation acts as an additional relaxation mechanism. The possible quenching of the hfs and decomposition of the complicated many-level spectra into several simple one-level ones is considered. (D.L.C.)

19667 ENERGY SHIFT IN THE RESONANT ABSORPTION OF γ-RAYS DUE TO DISORDERING OF THE LATTICE. Srivastava, B. P.; Sharma, H. N. K.; Bhattacharya, D. L. (Banaras Hindu Univ., India). Phys. Status Solidi (b); 49: No. 1, 329-37(1 Jan 1972).

A theoretical expression for the energy shift of the resonant absorption of γ rays by a disordered lattice is derived, using the double-time Green's function and taking a simplified model of a vacancy and an interstitial pair in the lattice. Considering only nearest-neighbor interactions in the harmonic approximation, it is found that, in addition to the energy shift due to the second-order Doppler effect, there is an additional shift due to the disordering of the lattice that depends on the position coordinate of the interstitial atom, the changed force constant of this atom, and the temperature. (auth)

19668 MOESSBAUER STUDY OF PROTON IRRADIATION EFFECTS IN POTASSIUM IRON CYANIDES. Kisynska, K.; Kopcewicz, M.; Kotlicki, A. (Univ., Warsaw). Phys. Status Solidi (b); 49: No. 1, 85-90(1 Jan 1972).

The results of the Moessbauer study of potassium iron cyanides $K_4[Fe(CN)_6] \cdot 3H_2O$ and $K_3[Fe(CN)_6]$ irradiated with 1.5-MeV protons are reported. The observed changes in the Moessbauer spectra are interpreted as a result of radiation damage effects and thermal disintegration processes of the compounds. The formation of metallic iron in the superparamagnetic state was observed. (auth)

19669 NMR BEHAVIOR OF THE COMPOUND CeAl. Niculescu, V.; Pop, Iuliu; Rosemberg, M. (Univ., Bucharest). Stud. Univ. Babes-Bolyai, Ser. Phys.; 16: No. 2, 59-67(1971). (In Rumanian).

The magnetic susceptibility of CeAl was studied by means of NMR techniques. The compound exhibits a paramagnetic behavior according to the Curie–Weiss law, assuming an independent temperature term $\chi_0 = 0.16 \times 10^{-5}$ μem/g. Exchange polarization of the RKKY type between the 4f and conduction electrons, with a negative exchange constant $J_{sf} = -0.25$ eV that indicates an antiferromagnetic character of the sf coupling, was found. (tr-auth)

19670 ELECTRON-SPIN RESONANCE OF RARE-EARTH IONS IN THE ACTINIDE CUBIC METAL Th. Davidov, D. (Univ. of California, Los Angeles); Orbach, R.; Rettori, C.; (and others). Phys. Rev., B; 5: No. 5, 1711-16(1 Mar 1972).

The electron-spin resonance of Gd, Er, and Dy of nominal concentrations between 40 and 3250 ppM in the actinide metal Th is reported. The temperature dependence of the linewidth yields values for the exchange coupling J_{fs} between the rare-earth localized moment and the conduction electrons. J_{fs} is found to be almost independent of the 4f occupation number, in agreement with the values of J_{fs} obtained previously by others from superconducting-transition-temperature measurements in the same alloys. (auth)

19671 ^{115}In KNIGHT SHIFTS IN LIQUID In ALLOYS CONTAINING SMALL AMOUNTS OF Pb. Carter, G. C.; Bennett, L. H. (National Bureau of Standards, Gaithersburg, Md.). Phys. Rev., B; 5: No. 5, 2022-3(1 Mar 1972).

Measurements of the nuclear magnetic resonance of ^{115}In in very dilute Pb in In liquid alloys were made. No structure was observed in the Knight shift vs composition behavior. (auth)

19672 NUCLEAR-MAGNETIC-RESONANCE INVESTIGATION OF PROTON MOTION IN SCANDIUM HYDRIDE. Weaver, H. T. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., B; 5: No. 5, 1663-7(1 Mar 1972).

Hydrogen diffusion processes in nonstoichiometric scandium hydrides were investigated using transient NMR methods. Activation energies (E_A) were found to be strongly concentration-dependent, with two processes becoming evident as the hydrogen-to-metal ratio (x) approached 2. The variation of E_A with x is interpreted as an effect of nonrigid-band behavior for the electron states. Both relaxation-time analysis and rigid-lattice linewidths suggest appreciable occupation of octahedral sites normally vacant in other dihydrides. (auth)

19673 INHOMOGENEOUS DENSITY OF ELECTRON STATES AND ELECTRIC-FIELD GRADIENT IN V_3Au AND ITS INFLUENCE ON THE NMR PROPERTIES IN THE NORMAL AND SUPERCONDUCTING STATES. Ancher, L. J. (Rijksuniversiteit,

Leiden); Poulis, N. J.; Wulffers, L. A. G. M.; Diemer, E. A. P.; Van Reuth, E. C. Physica; 56: No. 2, 268-85(30 Nov 1971).

NMR experiments on the intermetallic compound V_3Au require the revision of current theories for the ^{51}V resonance spectrum in this compound. The model proposed is based on two assumptions, both of which depend on ordering effects. First, it is postulated that the distribution of the density of states for the vanadium 3-d electrons at the Fermi level $N_d(E_F)$ is inhomogeneous. Secondly, it is assumed that the electric-field gradient is very sensitive to the length of the vanadium chains in V_3Au. This length depends on the degree of ordering in the compound. Former experiments on the Knight shift in V_3Au in the normal state, together with new experiments performed in the superconducting state, are explained by the proposed model. (auth)

19674 PROTON-ENHANCED NUCLEAR INDUCTION SPECTROSCOPY. A METHOD FOR HIGH-RESOLUTION NMR OF DILUTE SPINS IN SOLIDS. Pines, A.; Gibby, M. G.; Waugh, J. S. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 56: No. 4, 1776-7(15 Feb 1972).

The method combines double resonance and spin decoupling. It comprises the steps of: (1) polarize the abundant spins (I) in a high field; (2) cool I to a low spin temperature in the rotating frame; (3) establish I contact with the rare spins S for a time τ; and (4) record the S free induction decay while decoupling I. Steps 3 and 4 are repeated $\sim N_I/N_S$ times during which the I polarization is depleted and the S signal accumulated. The expected gain $(N_I/N_S)(\gamma_I/\gamma_S)^2 \sim 10^3$ was confirmed for the natural abundance of ^{13}C in solid adamantane. The advantage of this method over indirect-detection methods is that the complete S-spin spectrum is obtained in one shot, following a single polarization of the I spins. (D.L.C.)

19675 NUCLEAR MAGNETIC RESONANCE STUDY OF TRANSITION METAL MONOBORIDES. I. ^{11}B NUCLEAR ELECTRIC QUADRUPOLE INTERACTION PARAMETERS. Creel, R. B.; Barnes, R. G. (Ames Lab., Iowa). J. Chem. Phys.; 56: No. 4, 1549-62(15 Feb 1972).

Measurements are reported of the nuclear electric quadrupole interaction parameters (coupling constant and asymmetry parameter) of the ^{11}B nuclear magnetic resonance spectra of the transition metal monoborides, MB (M = Ti, V, Cr, Co, Ni, Mo, and W). A detailed account is given of the method of extracting these parameters from the experimental spectra with the aid of computer-synthesized spectra. The measured ^{11}B quadrupole couplings and asymmetry parameters are quite small and are inconsistent with the assumption that the boron atoms in these borides are linked by strong covalent sp hybrid bonds. (39 references) (auth)

19676 RADIATIVE DETECTION OF NMR USING THE MOESSBAUER EFFECT. Cain, G. (Monash Univ., Clayton, Australia). Phys. Lett.; 38A: No. 4, 279-80(14 Feb 1972).

NMR was observed in ^{57}Co dissolved in iron by measuring a change in the Moessbauer effect spectrum at 0.07°K. (auth)

19677 OBSERVATION OF AMPLITUDE MODULATION OF 14.4-keV GAMMA RAYS. Isaak, G. R. (Univ. of Birmingham, Eng.); Preikschat, E. Phys. Lett.; 38A: No. 4, 257-9(14 Feb 1972).

Sidebands of the 14.4-keV gamma radiation from ^{57}Fe are produced by amplitude modulation at 6.26 MHz. The resonant absorption is also decreased for modulation frequencies below 2.11 MHz, which suggests the presence of higher-frequency components. (auth)

19678 MOESSBAUER EXPERIMENTS IN EXTERNAL MAGNETIC FIELDS. Shinjo, Teruya; Takada, Toshio (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 5, 314-21(Sep 1971).

A strong magnetic field produced by a superconducting magnet is very useful for Moessbauer spectroscopic investigations. The following results were obtained, utilizing the high-field Moessbauer technique: (1) impurity Fe in γ-Mn has no localized magnetic moment; (2) the transferred hyperfine magnetic field at Fe in ferromagnetic CoS_2 was determined; (3) the ion distribution in the manganese ferrite prepared by a wet method was estimated and the spin arrangement was confirmed to be collinear; and (4) an unusual behavior was observed in the field dependence of vivianite, $Fe_3(PO_4)_2 8H_2O$; only one of the two Fe sites showed a spin-flipping phenomenon. (auth)

Theory

Refer also to abstracts 18784 and 18789.

19679 METAL HYDRIDES: STRUCTURE AND BAND STRUCTURE. Switendick, A. C. (Sandia Labs., Albuquerque, N. Mex.). Int. J. Quant. Chem., Symp.; No. 5, 459-70(1971).

From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

Previous calculations for Group IIIB transition metal and rare earth compounds with hydrogen showed that for the dihydrides a new band is added below the Fermi energy. This bond corresponds to the antibonding combination of the two hydrogen 1s orbitals in the unit cell. The original transition metal s band hybridizes with the bonding combination of the two hydrogens, the implications being that for compounds with only one hydrogen per unit cell no new band is formed and the additional electron goes into host metal states. This result has now been verified by calculations for YH and PdH. Previous conclusions about the relative stability of the trivalent trihydrides have been extended to Groups IVB, VB, and VIB dihydrides. The relative position of the added hydrogen bands below the Fermi energy determines the relative stability of a structure. This position depends primarily on interatomic distance. Thus the trihydride forms only for yttrium and the rare earths and not for scandium. The dihydride only forms for transition metals and rare earths for which the metal ion radius (which determines the metal spacing but not the structure) is greater than 1.25 Å. The monohydride forms only when the dihydride is relatively unstable and the density of states in the d band is high, e.g. VH, NbH, TaH, NiH, and PdH. Quantitative substantiation of these ideas from band structure calculations will be presented. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 17851, 18783, 18789, 19098, 19144, 19148, 19151–19153, and 19457.

19680 MOTION OF CHARGED PARTICLES IN CERTAIN AXISYMMETRIC ELECTROMAGNETIC FIELDS. Glikman, L. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1266-7(Feb 1972).
Translated from Zh. Tekh. Fiz.; 41: No. 8, 1608-10(Aug 1971).

A study is made of the motion of charged particles in certain constant axisymmetric electromagnetic fields in the nonrelativistic, relativistic, and ultrarelativistic cases. The first integral of the Hamilton–Jacobi equation is found for certain fields. These include a magnetic dipole and a magnetic prism. (auth)

19681 PHASE-DENSITY REDISTRIBUTION IN CHARGED-PARTICLE BEAMS. Kuznetsov, V. S.; Abroyan, M. A.; Solnyshkov, A. I.; Fidel'skaya, R. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1268-72(Feb 1972).
Translated from Zh. Tekh. Fiz.; 41: No. 8, 1611-17(Aug 1971).

The phase-density distribution f in high-intensity proton beams is investigated. The distribution f in real beams differs substantially from the microcanonical distribution. From a numerical solution of the equation system for a beam with arbitrary f it is shown that a phase-density redistribution occurs; this produces a current-density redistribution and distortion of the phase-space configuration. This work provides experimental confirmation of the current-density redistribution. (auth)

19682 CLASSICAL LIMIT AND THE WKB APPROXIMATION. Brown, Lowell S. (Univ. of Washington, Seattle). Amer. J. Phys.; 40: No. 3, 371-6(Mar 1972).

It is proved that a wave-packet solution in the WKB approximation to the Schroedinger equation follows the classical trajectory, and the nature of this solution is discussed. (auth)

19683 SOLUTION OF A ONE-DIMENSIONAL THREE-BODY PROBLEM IN CLASSICAL MECHANICS. Khandekar, D. C.; Lawande, S. V. (Bhabha Atomic Research Centre, Bombay). Amer. J. Phys.; 40: No. 3, 458-62(Mar 1972).

A one-dimensional problem of three equal particles interacting pairwise via a potential that is the sum of a quadratic and an inversely quadratic term is discussed from the point of view of classical mechanics. It is shown that the quantum energy spectrum can be obtained from the classical theory of action-angle variables and Bohr–Sommerfeld rules. (auth)

19684 NOTE ON FUNCTION SPACES SPANNED BY COMPLEX ENERGY EIGENFUNCTIONS. Berggren, T. (Lund Inst. of Tech., Sweden). Phys. Lett.; 38B: No. 2, 61-3(24 Jan 1972).

It is shown that, by expressing the wave functions in momentum space, it is possible to introduce topologically useful norms in the space spanned by certain sets of complex energy eigenstates of the free-particle Hamiltonian. (auth)

19685 QUANTUM THEORY IN THE CLASSICAL LIMIT. Cohn, Jack (Univ. of Oklahoma, Norman). Amer. J. Phys.; 40: No. 3, 463-7(Mar 1972).

The problem of the reduction of quantum mechanics to classical mechanics is considered. It is demonstrated that the customary derivation of classical mechanics from the Schrödinger equation via the Hamilton–Jacobi action equation is incomplete. An improved derivation, involving the expectation value of the action, rather than the action itself, is given. Under this formulation the Hamilton–Jacobi description of classical mechanics is obtained from quantum mechanics, for suitable wave packets as h goes to zero. (auth)

19686 LARGE-ω ASYMPTOTIC EXPANSIONS AND PADE APPROXIMANTS FOR THE HARMONIC OSCILLATOR. Osche, G. R. (Monmouth Coll., West Long Branch, N. J.); Iafrate, G. J. J. Chem. Phys.; 56: No. 3, 1104-12(1 Feb 1972).

An approximate solution to the Schrödinger equation for a particle in various perturbed harmonic-oscillator potentials is obtained by utilizing large-ω (ω is the natural frequency of unperturbed oscillator) asymptotic expansion theory. Both the basic asymptotic and perturbation theory solutions are obtained and are shown to be related. Explicit high-order perturbation expansions for the energy and mean-square displacement of the symmetric anharmonic oscillator are obtained and are seen to be divergent but asymptotic. It is shown that by rearranging these expansions as Padé approximants, accurate numerical values are obtained for these observables, even for nonperturbative values of the coupling constant. (auth)

19687 PROBLEMY DIFFRAKTSII I RASPROSTRANENIYA ELEKTROMAGNITNYKH VOLN. (Problems of Diffraction and Propagation of Electromagnetic Waves). Fok, V. A. Moscow; Sovetskoe Radio (1970). 519p.

In the first part of this book an asymptotic diffraction theory is developed, based on the author's local field principles in the penumbra region at surfaces of highly conducting convex bodies. In the second part, the problems of radio-wave propagation in homogeneous and nonhomogeneous (lamellar) atmospheres are considered, with calculation of diffraction in the neighborhood of the Earth's surface. In three appendixes, there are presented, respectively, the following: (1) the theory of integral equations used in the text, (2) tables of Airy functions, and (3) auxiliary functions used for calculation of current distributions. (44 references) (tr-auth)

19688 APPLICATIONS OF HYPERDIFFERENTIAL OPERATORS TO QUANTUM MECHANICS. Miller, Marvin; Steinberg, Stanly (Purdue Univ., Lafayette, Ind.). Commun. Math. Phys.; 24: No. 1, 40-60(1971).

Various applications of the theory of hyperdifferential operators to quantum mechanics are discussed. A concise summary of the relevant aspects of the theory is presented and then used to derive a variety of operator identities, expansions, and solutions to differential equations. (auth)

19689 QUANTIZATION OF A KINETIC ENERGY WITH VARIABLE INERTIA. Hofmann, Helmut (Gesellschaft fuer Kernforschung, Karlsruhe, Ger. Univ., Heidelberg). Z. Phys.; 250: No. 1, 14-26(1972).

It is shown that fundamental properties of kinetic energy determine its operator in wave mechanics almost completely: The part containing differential operators is unequivocally given by the Laplacian calculated for the metric, which is defined by the classical kinetic energy. The only remaining ambiguity is an additive scalar function proportional to $\hbar^2$. Invariance properties with respect to infinitesimal transformations may reduce the number of coordinates on which this function depends. In certain cases it must be constant. (auth)

19690 EXPANSION OF TWO PARTICLE HARMONIC OSCILLATOR WAVEFUNCTION PRODUCTS. Domany, E. (Nuclear Research Centre, Beer-Sheva, Israel). J. Phys., A (London); 5: No. 2, 241-5(Feb 1972).

Second quantization is used to expand the product of two harmonic oscillator wavefunctions of two different particles, centered on different sites, in terms of relative and centre-of-mass coordinate dependent functions. (auth)

19691 SCHROEDINGER'S EQUATION AND SPECIAL RADIAL ELECTRIC FIELDS. Hautot, A. P. (Univ., Liege). Phys. Lett.; 38A: No. 5, 305-6(28 Feb 1972).

Schroedinger's equation is exactly soluble if one considers a central potential of the type $Ar^2 + Br - D/r$, provided D takes particularly well chosen values. (auth)

19692 PARTICLE–HOLE COMPONENT OF THE 2-PARTICLE GREEN FUNCTION: ITS RELATION TO THE CANONICAL PARTICLE–HOLE STATES AND ITS N-REPRESENTABILITY. Larson, Everett G.; Day, Orville W. (Brigham Young Univ., Provo, Utah). Int. J. Quant. Chem., Symp.; No. 5, 729-44(1971).
From International symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (18 Jan 1971).

The relation between the 2-particle Green function and the projections of the excited states onto the particle–hole space of the ground state of a fermion system is derived for the case in which the spectrum of the Green function is totally discrete. From this relation, the conditions for the N-representability of the 2-particle Green function are obtained, as is an explicit representation of the projection operator for the particle–hole space. The projection operator for the 2-particle–2-hole space is also presented. (auth)

19693 CLASSICAL AND QUANTUM MECHANICS IN AUXILIARY ALGEBRAS. Gregin, Emile; Petersen, Aage (Yeshiva Univ., New York). Phys. Rev., D; 5: No. 2, 300-6(15 Jan 1972).

A canonical algebra is defined as the algebraic structure common to classical and quantum mechanics. It is a linear space

equipped with two bilinear operations: an associative product and a Lie product that is a derivation with respect to the associative product. In addition, the Lie products of the generators of this algebra are constants. The problem of the algorithmic formulation of a canonical algebra in terms of an auxiliary associative algebra is solved. The first part of the problem consists of finding all auxiliary algebras that can algorithmically support a canonical structure. The second part consists of finding all canonical algebras that can be formulated in terms of a given auxiliary structure. (auth)

19694 NEW METHOD FOR SOLVING EIGENVALUE PROBLEMS. Wasserstrom, E. (Bell Telephone Labs., Murray Hill, N. J.). J. Comput. Phys.; 9: No. 1, 53-74(Feb 1972).

A new method for calculating eigenvalues of ordinary differential operators is presented. After imbedding the given operator into a suitable one-parameter family of operators, the eigenvalue problem is reformulated as an initial-value problem. A numerical scheme for solving the initial-value problem is described, and results of several examples are displayed. Both the self-adjoint and non-self-adjoint cases are treated. It is advantageous to supplement the above method by an efficient iterative scheme, and an example of the latter is therefore shown. Finally, the advantages and drawbacks of the method are briefly discussed. (35 references) (auth)

19695 RADIAL AUXILIARY FUNCTIONS FOR MANY-ELECTRON INTEGRALS. Gruninger, John (West Virginia Univ., Morgantown). Int. J. Quant. Chem., Symp.; No. 4, 385-9(1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

Series solutions to the radial auxiliary integrals that are needed for the evaluation of many-electron integrals are given. These auxiliary integrals will facilitate the calculation of all the many-electron integrals that occur in Hylleraas-type wave functions, which involve r_{ij} terms with linked indices. (auth)

19696 ALTERNATIVE TIME-DEPENDENT HAMILTONIANS BY INFINITESIMAL TRANSFORMATIONS. Hansen, Aage E. (Univ. of Copenhagen). Int. J. Quant. Chem., Symp.; No. 4, 473-8(1971).

From Symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, Fla. (19 Jan 1970).

Four equivalent Hamiltonians for a single bound electron in an external electromagnetic field are derived by quantum mechanical infinitesimal transformations. Some general expressions for infinitesimal transformations of perturbation terms are presented. (auth)

19697 INVARIANCE PROPERTIES FOR QUANTUM SYSTEMS WITH SLOW DISTURBANCE. Sofonea, L. (Polytechnical Inst., Brasov, Rumania). Stud. Cercet. Fiz.; 23: No. 10, 1193-1212(1971). (In Rumanian).

Discussion is presented under the following topics: (1) sudden disturbance vs slow disturbance of quantum systems; (2) adiabatic invariance of classical mechanics; and (3) adiabatic invariance of quantum mechanics. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstracts 17662, 17672, and 18155.

19698 (ANL–7900) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, DECEMBER 1971. (Argonne National Lab., Ill.). 28 Jan 1972. Contract W-31-109-eng-38. 169p. Dep. NTIS.

Highlights of project activities for December 1971 are summarized. The EBR-II operations and testing are reported. Heat transfer and fluid flow studies for LMFBR design support are reviewed. The development of FFTF instrumentation is summarized. Monitoring and sampling methods and devices are examined for liquid sodium systems. Studies of LMFBR fuels and materials, fuel cycles, physics, and safety are described. Thermal plume dispersion from reactor outfalls was investigated. Gas cooled fast reactor fuel element performance was examined. (H.D.R.)

19699 ENGINEERING FOR NUCLEAR POWER. 1971 BULLEID MEMORIAL LECTURES, VOLUME V. Stewart, J. C. C.; Seymour, D. F.; Brown, Gordon; Wolff, P. H. W. Nottingham, Eng.; University of Nottingham (1971). 117p. £ 7.00.

Four lectures are presented. The first reviews the development of power reactors in the United Kingdom, and provides a framework for the remaining lectures which are concerned with engineering aspects of gas-cooled, water cooled, and fast reactors respectively. Separate abstracts are presented for each lecture. (UK)

Physics and Core Engineering

19700 (BAW–10036) CORRELATION OF CRITICAL HEAT FLUX IN A BUNDLE COOLED BY PRESSURIZED WATER. (Nonproprietary Version of BAW–10000, Supp. 1). Morgan, C. D. (Babcock and Wilcox Co., Lynchburg, Va.). Jan 1972. 37p.

The data used to justify heat transfer correlations for pressurized water reactor fuel bundles are presented. Answers to questions on critical heat flux testing and analysis in rod bundles are summarized. (H.D.R.)

19701 (JAPFNR–16) REPORT ON THE RESULTS OF RESEARCH AND EVALUATION OF THE METHOD FOR THE DESIGN OPTIMIZATION OF FAST REACTOR CORE. (Hitachi, Ltd., Tokyo (Japan)). Translation of report PNC-J–202-71-6. 52p. Dep. NTIS (U. S. Sales Only).

A fast reactor design optimization system to automatically optimize the reactor core is described. The main function of this system is to use systematically the data derived from different fields related to the design of the fast reactor and thereby obtain the optimum design point under the given design criteria to logically minimize the cost of power generation. The term "optimization" used here is to determine a design point which minimizes the cost of power generation when the nuclear reactor is in normal operation. (auth)

19702 EFFECT OF UNCERTAINTY OF FUEL BURN-UP KNOWLEDGE ON ITS ECONOMICS. Meyer, K. (Ingenieurhochschule, Zittau, Ger.). Kernenergie; 14: No. 7-8, 235-8 (Jul-Aug 1971).

A simple model has been developed for studying the effect of uncertainty of the fuel burnup state on prediction of the duration of operation, yielding an integral equation which enables the distribution of fuel elements at the end of operation to be calculated. The relative change of duration of operation is found to be of order of δ^2 if δ is the mean relative uncertainty of knowledge of fuel element burnup. 4 references. (auth)

19703 PARAMETRIC STUDY OF THE REACTOR PHYSICS DESIGN OF A SODIUM-COOLED FAST POWER REACTOR. Mueller, A.; Schott, H.; Wolter, W. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 14: No. 7-8, 239-47 (Jul-Aug 1971). (In German).

Critical mass of fissile material, total breeding factor, doubling time, and other physical characteristics of a 1000 MW(e) sodium-cooled fast reactor are calculated as functions of various geometric and thermodynamic-hydraulic core parameters. The power density in the cylindrical core is flattened by introducing two regions of different enrichment of fissile material. In all cases fuel of the core is a mixture of UO_2/PuO_2, and fuel of the blanket is UO_2. The following parameters are varied: core volume (mean power density), fuel volume fraction, height-to-diameter ratio of the core, fuel element diameter, maximum rod power, and maximum flow rate of the coolant or pressure loss in the core. The results of these computations may be used for selection of optimum design parameters. 13 references. (auth)

Control and Instrumentation

19704 (ANL–EBR–41) SAFETY ANALYSIS OF THE EBR-II HIGH-TEMPERATURE NUCLEAR INSTRUMENT TEST FACILITY (NITF). Wilkes, C. W.; Cerchione, J. D.; Rice, R. E.; Long, P. M. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Oct 1971. Contract W-31-109-eng-38. 53p. Dep. NTIS.

The NITF provides a high-temperature (up to 1200°F) facility with high neutron and gamma fluxes for testing and development of neutron sensors and circuits. The facility was designed to satisfy the requirements of the AEC's Liquid Metal Fast Breeder Reactor Program. It has been installed in the J-2 instrument thimble of the EBR-II reactor, tested, and accepted as a high-temperature experimental facility. Safety considerations were evaluated for three areas: modification of the J-2 thimble so it would accept the new facility, operation of the NITF at high temperature, and removal and handling of activated instruments and equipment. The evaluation shows that installation and operation of the NITF will not endanger personnel or equipment and that plant operation will not be affected. No unsafe or hazardous conditions will be imposed over and above those imposed by other instrument thimbles in the EBR-II. A shielded space has been prepared in the reactor-building storage pit for remotely handling the detectors and their carrier. 8 references. (auth)

19705 (BAW–10029) CONTROL ROD DRIVE MECHANISM TEST PROGRAM. (Nonproprietary Version of BAW–10007, Rev. 1). Ficor, John; Williams, James T. (Babcock and Wilcox Co., Lynchburg, Va.). Jan 1972. 85p.

The testing and development of three control rod drive mechanisms for use on commercial PWR plants are described. Each of the drives and the individual testing performed to verify the structural and functional adequacy of each drive are examined. The test results indicate that all three drives are reliable and ensure safe, dependable reactor operation. (auth)

19706 (JAPFNR–20) RESEARCH AND DEVELOPMENT OF THE METHOD OF CALCULATION OF CONTROL ROD WORTH BY MONTE CARLO METHOD. ANALYSIS OF APPLICABILITY OF THE MONTE CARLO CODE MONEX-ROD. Nakamura, H. (Fuji Electric Co. Ltd., Tokyo (Japan)). Translation of report PNC-J–203-71-3-1. 15p. Dep. NTIS (U. S. Sales Only).

For the purpose of calculating the control rod reactivity in the fast reactor core system, a computer code MONEX-ROD is developed based on the Monte Carlo method. The results of experiments regarding the central control rod and the off-central control rod are compared with the results of calculations made by use of MONEX-ROD. The MONEX-ROD code can be effectively used in the analysis of the results of experiments on the control rod in the fast critical assembly and in the evaluation of the control rod reactivity in a fast reactor actually in use. (auth)

Coolant System

Refer also to abstracts 17676, 18183, and 18290.

19707 (ANL–7834) NOISE INVESTIGATION AND REPAIR OF THE EBR-II INTERMEDIATE HEAT EXCHANGER. EBR-II Project. Buschman, H. W.; Cerutti, B. C.; Clark, A. F. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 83p. Dep. NTIS.

On the night of November 14, 1970, a loud banging noise was heard in the vicinity of the EBR-II intermediate heat exchanger (IHX). Indications were that the noise source was within the IHX inlet pipe. A port for access to the IHX internals was installed on the inlet-pipe elbow over a rectangular hole cut in the elbow. Visual examinations using both a periscope and a remote TV system revealed that of the two support clips holding a 1-in.-dia evacuation tube in place, the top clip was loose and the bottom

clip was missing. This condition allowed the evacuation tube to move because of the secondary-sodium flow stream and vibrate against the wall of the 12-in.-dia inlet pipe. Evidence of wear on both the 12-in. pipe and the 1-in. tube was found. The upper clip was removed; the evacuation tube was cut at the top and bottom and removed. The lower clip was not found. The section cut out of the inlet elbow was rewelded in place and the secondary system was restored to operational status. Quiet operation of the IHX verified that the repair was successful. (auth)

19708 (ANL/EBR-52) PURITY OF EBR-II PRIMARY COVER GAS. Cutforth, D. C.; Perry, W. H. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Nov 1971. Contract W-31-109-eng-38. 31p. Dep. NTIS.

The primary cover gas of Experimental Breeder Reactor II (EBR-II) is continuously monitored for oxygen, nitrogen, and hydrogen content. A program was started in March 1968 to identify the sources of these impurities and to reduce their level in the cover gas. At that time, the nitrogen concentration averaged about 6000 ppM with short-term levels as high as 20,000 ppM; the hydrogen concentration was occasionally as high as 400 ppM. Nitrogen (from air) was found to be introduced primarily through the argon cooling system of the fuel-unloading machine and through the fuel-holddown packing gland during fuel-transfer operations in the primary tank. The principal source of hydrogen (moisture) was traced to inadequate drying of the interbuilding fuel-transfer cask (or coffin). Modifications of equipment significantly reduced the frequency and magnitude of inleakages of impurities. (auth)

19709 (JPRS-55103) DISSOCIABLE NITROGEN TETROXIDE: A PROMISING COOLANT AND WORKING MEDIUM FOR NUCLEAR ELECTRIC POWER PLANTS WITH GAS-COOLED FAST REACTORS. Nesterenko, V. B. Translated from Teploenergetika; No. 1, 72-8(1971). 16p. NTIS.

The effects of heat exchange cycles on the economics of gas cooled fast reactors are discussed. The properties of the dissociating gas N_2O_4 are described, and closed gas and gas–liquid cycles using N_2O_4 are examined. Helium, CO_2, and N_2O_4 cooling systems are compared for fast reactors. (31 references) (H.D.R.)

19710 PUMPS FOR NUCLEAR POWER STATIONS. Frei, A.; Kuendig, J. Sulzer Tech. Rev.; 53: No. 3, 135-44(1971).

The construction of nuclear power stations brought about some new areas of use for centrifugal pumps (reactor circulating pumps). In addition, pumps which were already well-known in conventional thermal power stations had to be adapted to meet the specific requirements of nuclear power station operation (feed and condensate pumps). Particularly complicated problems in respect to the stringent demands placed on the shaft seals and the constructional materials to be used when pumping radioactive and corrosive water had to be studied and solved. The fact that reactor circulating pumps are fitted inside the so-called radiation shield and are therefore not accessible during operation of the power station had also to be taken into account. (auth)

19711 CONTROL OF PRESSURE IN PRIMARY COOLANT SYSTEM OF NUCLEAR REACTOR. Klingbeil, H. N.; Cliffe, W. W.; Castell, W. A. (to Canadian General Electric Co. Ltd.). Canadian Patent 886,244. 16 Nov 1971.

A nuclear reactor and steam turbine, in which primary coolant from the reactor is used to generate steam for the turbine from light water, are provided with a pressure monitor in the secondary steam circuit. This monitor is connected to the primary coolant circuit to limit or reduce pressure in response to a rise in secondary pressure at a rate in excess of that normally experienced from an operational transient. In the event of turbine trip-out, the growth of peak pressure in the reactor coolant circuit can be anticipated. (F.S.A.) (Canada)

Fuels and Fuel Elements

19712 (ANL-6795) IRRADIATION BEHAVIOR OF URANIUM-FISSIUM ALLOYS. EBR-II Project. Kittel, J. H.; Horak, J. A.; Beck, W. N.; Fousek, R. J. (Argonne National Lab., Ill.). Oct 1971. Contract W-31-109-eng-38. 46p. Dep. NTIS.

A series of uranium-fissium and uranium-fissium-zirconium alloys was irradiated in thermal test reactors to study the relationship of dimensional stability to alloy composition, thermal cycling, burnup, irradiation temperature, postirradiation heating, and cladding restraint. Uranium-atom burnups as high as 6.2% were achieved, and center fuel temperatures were in the range of 170-790°C. None of the alloy compositions tested showed irradiation behavior superior to the uranium-5 wt % fissium alloy that has been used as driver fuel in EBR-II since it began operation. This alloy is among those uranium-base alloys most capable of resisting high-temperature irradiation swelling. None of the alloys showed evidence of the reversion to the metastable gamma phase that has been observed in comparable uranium-molybdenum alloys. Swelling of uranium-fissium alloys was effectively restrained by most of the 0.009-in.-thick cladding materials investigated. Local hydrostatic forces due to swelling of the fuel caused the fuel to extrude extensively out of small vent holes in the cladding. Little axial fuel movement occurred within the cladding, however, even when the upper fuel surface was entirely unrestrained. (28 references) (auth)

19713 (ANL-EBR-50) COMPILATION AND REVIEW OF EXISTING SAFETY ANALYSES FOR FUELED SUBASSEMBLIES IN EBR-II. EBR-II Project. Gillette, J. L. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Dec 1971. Contract W-31-109-eng-38. 25p. Dep. NTIS.

The results of studies dealing with the safety considerations of fueled subassemblies in EBR-II are summarized. Most of these studies are concerned with the response of oxide-fueled subassemblies to the abnormal incidents postulated and analyzed in the EBR-II safety documents; others deal with the overall behavior of the reactor or with the response of the plant protective system to these incidents. Safety studies on metal-fueled subassemblies are also presented so that a basis for comparison can be established. 19 references. (auth)

19714 (WCAP-4167-2) EEI-WESTINGHOUSE PLUTONIUM RECYCLE DEMONSTRATION PROGRAM PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 1970. Haley, J. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Mar 1971. Contract AT(30-1)-4167. 268p. Dep. NTIS.

For Edison Electric Inst., New York.

The EEI-Westinghouse Plutonium Recycle Program is described from inception, in 1968, through December 1970. The final reports for the Preliminary Region Design, the Demonstration Assembly Design, and the Demonstration Assembly Fabrication are included. The specification for fabrication of PuO_2–UO_2 pellets and the results of measurements of PuO_2 particle size distribution in the mixed-oxide fuel are presented. A separate abstract was prepared for each of the 5 sections. (H.D.R.)

For abstracts of individual sections see: 19715–19719.

19715 (WCAP-4167-2, Encl.1) PLUTONIUM DIOXIDE–URANIUM DIOXIDE PELLET SPECIFICATION. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Mar 1971. 6p.

In EEI-Westinghouse plutonium recycle demonstration program progress report for the period ending December 1970.

The specification for fabrication of plutonium recycle pellet fuel for pressurized water reactors is presented. The fabrication requirements apply to solid cylindrical PuO_2–UO_2 fuel pellets in the sintered and ground condition and fabricated by mechanically mixing, cold pressing, and sintering. (H.D.R.)

19716 (WCAP-4167-2, Encl.2) PLUTONIA PARTICLE SIZE DISTRIBUTION IN EEI DEMONSTRATION FUEL. Hott, A. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Mar 1971. 26p.

In EEI-Westinghouse plutonium recycle demonstration program progress report for the period ending December 1970.

The distribution of PuO_2 particles was studied in mechanically mixed fuel. Measurements were performed on random planar sections using the electron microprobe and alpha radiographic techniques. Analysis of the data indicated a log normal distribution of frequencies of particle intercepts with a random plane. A more conservative extrapolation of the tail portion of this curve provided a means for determining frequencies of large intercept sizes. The distribution of frequencies of large particles in a random volume was calculated from the larger intercept frequencies and the extrapolated portion of the intercept distribution. Maximum expected intercept size for the cylindrical surface of a random pellet is 170 μm; the maximum expected particle occurring in the outer 400 μm thick shell is 205 μm. (auth)

19717 (WCAP-4167-2, Sect.3) PRELIMINARY REGION DESIGN. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Mar 1971. 48p.

In EEI-Westinghouse plutonium recycle demonstration program progress report for the period ending December 1970.

In order for plutonium recycle to be commercially available for pressurized water reactors in the mid-1970's, core region design studies show that the fuel will have the following characteristics: (1) Plutonium recycle will constitute less than 15% of the fuel dur-

ing the 1970's. (2) The reload region will have the same mechanical design for both the plutonium recycle and enriched uranium assemblies. (3) The recycle assemblies will consist entirely of mixed-oxide fuel rods. (4) There will be three different plutonium enrichments in each recycle assembly. (5) Additional design work will be required to determine control rod worth and power distribution control requirements for each reactor. The preliminary design studies leading to the above conclusions are summarized. 11 references. (H.D.R.)

19718 (WCAP-4167-2, Sect.4) DEMONSTRATION ASSEMBLY DESIGN. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Mar 1971. 43p.

In EEI-Westinghouse plutonium recycle demonstration program progress report for the period ending December 1970.

Four fuel assemblies containing 720 PuO_2-UO_2, Zircaloy-4 clad fuel rods were inserted in the San Onofre power reactor during the first refueling. These plutonium recycle demonstration assemblies will be operated through the normal three reactor cycles, with removable rods subjected to interim examinations. The nuclear design, mechanical design, thermal-hydraulic design, and fuel pellet design of the recycle assemblies are summarized. Safety considerations are analyzed for a control rod ejection accident and for fuel handling. (H.D.R.)

19719 (WCAP-4167-2, Sect.5) DEMONSTRATION ASSEMBLY FABRICATION. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Mar 1971. 78p.

In EEI-Westinghouse plutonium recycle demonstration program progress report for the period ending December 1970.

A portion of the plutonium recycle demonstration program required the fabrication of 734 mixed-oxide fuel rods and 16 UO_2 replacement fuel rods. The fabrication facility is described, and all operations are summarized, including: receipt of plutonium nitrate solution; conversion to PuO_2 or mixed-oxide; blending the mixed-oxide; pellet fabrication; rod fabrication and inspection; recovery, purification and recycle of process scrap; and treatment of waste solids and solutions for disposal. (H.D.R.)

19720 FLOW DEFLECTOR FOR NUCLEAR FUEL ELEMENT ASSEMBLIES. (to Combustion Engineering Inc.). British Patent 1,260,790. 19 Jan 1972. Priority date 31 Dec 1969, United States.

REACTOR FUEL ELEMENTS—coolant flow deflectors for bundle arranged water cooled
REACTORS, WATER-COOLED—fuel element assemblies for, coolant flow deflectors for (D.C.G.)

19721 CROSSED URANIUM–PLUTONIUM AND THORIUM–URANIUM FUEL CYCLES FOR A DEVELOPING NUCLEAR POWER SYSTEM WITH THERMAL CONVERTERS AND FAST REACTORS. Wenzel, P. (Institut fuer Kraftwerke, Berlin). Kernenergie; 14: No. 7-8, 231-5(Jul-Aug 1971).

The nuclear power stations equipped with thermal reactors being presently planned or operated on a large scale, especially the light-water reactors, are, in spite of their good technical and economic parameters, not suitable for long-term nuclear power programs due to their bad fuel utilization. Only with the future breeder reactors is a satisfactory fuel utilization guaranteed. An example of a two-type strategy for thermal converters (pressurized-water reactors) and fast breeder reactors is given to explain how the coupling of both reactor types by their fuel cycles in the way of crossed progeny U-Pu and Th-U cycles can improve the fuel utilization of the thermal reactors. The demand for natural uranium and separative work for the whole nuclear power system will be considerably smaller compared with the U-Pu cycle alone. The PWR fuel cycle costs will decrease by 10 to 20%, and the FBR fuel cycle costs are not affected. 23 references. (auth)

Auxiliary Systems and Engineered Safeguards

19722 (ANL-7844) SAMPLING AND ANALYSIS OF EBR-II SODIUM. EBR-II Project. Olson, W. H. (Argonne National Lab., Ill.). May 1971. Contract W-31-109-eng-38. 25p. Dep. NTIS.

EBR-II sodium is sampled by two methods: overflow sampling and flow-through sampling. In overflow sampling, sodium from a spigot flows into and over the sides of a sample cup. In flow-through sampling, sodium flows directly through the sample vessel (a section of tubing or other container). In both methods, excess sodium used in flushing the sample vessel is returned to the system being sampled. Samples for radionuclide and trace-metal analyses are taken by the overflow method. Samples for oxygen, carbon, and hydrogen analyses are taken by the flow-through method. Principal radionuclides and their typical concentrations in EBR-II primary sodium are: ^{24}Na, 1400 $\mu Ci/g$; ^{22}Na, 5.0×10^{-2} $\mu Ci/g$; ^{137}Cs, 1.2×10^{-2} $\mu Ci/g$; and ^{131}I, 3.0×10^{-4} $\mu Ci/g$. Other radionuclides identified are ^{3}H, ^{117m}Sn, ^{113}Sn, ^{125}Sb, ^{110m}Ag, and ^{54}Mn. Principal metallic impurities and their typical concentrations in primary sodium are: Sn, 20 ppM; Pb, 10 ppM; and Bi, 2 ppM. Other metals of interest are all present in concentrations of <1 ppM. The only radionuclide in secondary sodium is ^{24}Na, 4.0×10^{-2} $\mu Ci/g$. Metals of interest in secondary sodium are all present in concentrations of <1 ppM. Carbon and oxygen in both sodium systems are present in concentrations of <2 ppM, hydrogen <0.1 ppM. (auth)

19723 (RDT-E-8-5-T(12-71)) EX-VESSEL HANDLING MACHINE FOR SODIUM COOLED REACTORS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Dec 1971. 23p. RSO.

The requirements for the design, material, fabrication, assembly, inspection, preoperational and acceptance testing, and delivery of ex-vessel handling machines and associated auxiliary equipment for use in refueling liquid sodium cooled nuclear reactor plants when in a shutdown condition are presented. (auth)

Operation and Economics

19724 (JPRS-55131) TECHNICAL-ECONOMIC ANALYSIS OF A CLOSED-CYCLE POWER PLANT WITH A NON-EQUILIBRIUM PLASMA MHD GENERATOR. Shumyatskii, B. Ya.; Kovbasyuk, V. I.; Shelkov, E. M.; Stolyar, L. P.; Miroshnichenko, V. N. Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1264-70(Nov-Dec 1971). 11p. NTIS.

The combination of a high-temperature gas-cooled reactor and a plasma MHDG (magnetohydrodynamic generator) may be one of the promising trends in the improvement of the technical and economic indices of a closed-cycle electric-power plant by means of decreasing specific capital expenditures in the enlargement of the unit capacity of the power units and increasing the thermodynamic efficiency of the cycle. Since even promising gas-cooled reactors provide a comparatively low level (1500–1700°C) of the deceleration temperatures at the input to the MHDG, the development of the conductivity necessary for the effective operation of the generator is possible only in non-equilibrium ionization of the alkali additive in the inert gases. Problems of the selection of the parameters of a closed-cycle power plant with a non-equilibrium MHDG are considered, and on the basis of design developments estimates of its economic indices are made. (auth)

19725 UK METHODS FOR STUDYING FUEL MANAGEMENT IN WATER MODERATED REACTORS. Fayers, F. J. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 1, 29-42(Jan 1972).

The evaluation of batch fuel management schemes for the SGHWR raises calculational problems basically similar to those in LWR's. The methods adopted for analyzing these are discussed. The simple methods of preliminary assessment and detailed schemes for quantitative evaluation are described. Finally experimental work performed to test the accuracy of the more advanced calculational methods is examined. (UK)

19726 TECHNICAL AND COMMERCIAL POLICY ASPECTS OF THE UK NUCLEAR FUEL CYCLE. Franklin, N. L. (British Nuclear Fuels Ltd., Risley, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 1, 17-22(Jan 1972).

The policy expected to emerge in the next decade in relation to nuclear fuel cycles is reviewed. Commercial policy is considered in the individual sectors of U supply, enrichment, reprocessing and fuel fabrication. The treatment of problems associated with technical development is discussed. The design of fuel elements and the development of the gas centrifuge are chosen to illustrate the importance of balance of considerations in technical policy. Experience in problems of in-core stability and fuel endurance in AGR's and mechanical behavior of graphite components in the HTR are discussed. (UK)

19727 GENERAL CONSIDERATIONS IN FUEL MANAGEMENT FOR THERMAL REACTORS. Tyror, J. G.; Fayers, F. J. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 1, 23-8(Jan 1972).

The basic requirements for a successful fuel management scheme are outlined. The change in objectives is traced as the reactor concept evolves through the assessment, design and operations stages. The techniques involved are briefly outlined.

Future aims are to increase the realism of theoretical modes and to improve accuracy and computer economy. Some numerical studies on the accuracy of the principle of separation are described for graphite moderated and water moderated systems. (UK)

19728 MATHEMATICAL-ECONOMICAL SIMULATION OF OPTIMUM INCORPORATION OF NUCLEAR POWER PLANTS INTO MAINS SYSTEM. Bathe, J.; Gerisch, G. (Ingenieurhoschschule, Zittau, Ger. Inst. fuer Energetik, Leipzig). Kernenergie; 14: No. 7-8, 216-21(Jul-Aug 1971).

Incorporation of nuclear power plants into national or international mains system is characterized as a problem of optimization, the solution of which requires mathematical simulation of the reproduction process in electric power supply. Solution procedure is presented as a model system consisting of the model for optimization of power plant structure and the model for optimization of the site distribution of nuclear power plants. Both models are described with respect to the mathematical formulation of objective function and secondary conditions. It is shown that differently accentuated problems of incorporating nuclear power plants into electrical grid are covered by the models. 11 references. (auth)

Safety and Siting

19729 (ANL-7864) INVESTIGATION OF THE DISTRIBUTION OF FISSION PRODUCTS AMONG MOLTEN FUEL AND REACTOR PHASES. PART I. THE DISTRIBUTION OF FISSION PRODUCTS BETWEEN MOLTEN IRON AND MOLTEN URANIUM DIOXIDE. Fischer, Jack; Schilb, John D.; Chasanov, M. G. (Argonne National Lab., Ill.). Oct 1971. Contract W-31-109-eng-38. 22p. Dep. NTIS.

The distributions of some of the more important heat-producing fission products between molten iron and molten uranium dioxide were studied in order to predict the fission-product heat distribution after a meltdown accident. The experiments were carried out in an arc-melting furnace. It was found that Y, La, Sr, Ba, Zr, Pr, Ce, and some Nb were distributed to molten UO_2 and that Mo, Ru, and some Nb were distributed to the molten Fe phase. (auth)

19730 (BAW-10035) FUEL ASSEMBLY STRESS AND DEFLECTION ANALYSIS FOR LOSS-OF-COOLANT ACCIDENT AND SEISMIC EXCITATION. (Nonproprietary Version of BAW-10008, Part 2, Rev. 1). DeMars, R. V.; Steinke, R. R. (Babcock and Wilcox Co., Lynchburg, Va.). Jan 1972. 72p.

The capability of the fuel assemblies to withstand the effects of a loss-of-coolant accident (LOCA) blowdown, the operational basis earthquake (OBE) and design basis earthquake (DBE), and the simultaneous occurrence of the DBE and LOCA are evaluated. This method of analysis is applicable to nuclear steam system contracts that specify the skirt-supported pressure vessel. Loads during the saturated and subcooled phases of blowdown following a loss-of-coolant accident were calculated. This LOCA loading is also applicable to all skirt-supported vessels. The seismic excitations will be determined for each reactor site. However, the description of reactor components, the analytical model, testing, and LOCA loadings is generally applicable. The maximum loads on the fuel assemblies were found to be below allowable limits, and the maximum deflections of the fuel assemblies were found to be less than those that could prevent the insertion of control rods or the flow of coolant through the core. Based on the results of this investigation, it is concluded that the fuel assemblies can withstand the loss-of-coolant accident and seismic excitation loadings individually, as well as a simultaneous LOCA and DBE, without exceeding allowable limits. (auth)

19731 (ORNL-TM-3626) EFFECT OF IRRADIATION ON THE FAILURE OF ZIRCALOY-CLAD FUEL RODS. Osborne, M. F.; Parker, G. W. (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 36p. Dep. NTIS.

A loss-of-coolant accident in a water-cooled power reactor probably would cause a rapid temperature excursion in the core. A program to investigate the behavior of the Zircaloy-clad UO_2 fuel rods in such a thermal transient was conducted. The results of fuel rod failure experiments in steam atmosphere on both irradiated and unirradiated fuel rods are discussed. The results were compared with the mechanical properties of Zircaloy, with related work by other experimenters, and with a failure model. Cladding expansions of 15 to 70% were observed with rods that ruptured in the temperature range 1450 to 2600°F with thermal pressures of 50 to 1000 psig. For irradiated rods at fast neutron exposures of $\sim 1 \times 10^{21}$ nvt (>1.0 MeV) the average expansion was about 70% of the expansion in unirradiated rods. These data correlate reasonably well with a failure model based on secondary creep. The results of these tests indicate that, in a LOCA, fuel rod expansion may cause enough flow restriction to impair the efficiency of emergency cooling. However, irradiation effects in the Zircaloy cladding appear to reduce the extent of expansion. (21 references) (auth)

19732 (TID-25898) ANALYSIS OF NUCLEAR POWER PLANT STRUCTURES, EQUIPMENT, AND SYSTEMS FOR SEISMIC LOADS. AN ASSESSMENT OF THE STATE OF THE ART. Young, G. A. (Agbabian-Jacobsen Associates, Los Angeles, Calif.). 29 Sep 1970. 34p. Dep. NTIS.

An assessment of present analysis procedures used in the design of nuclear power plants for seismic loads is presented. The objective is to define the most reliable analysis procedures currently available, and to indicate where additional studies can develop improved procedures at a modest cost and within a reasonable period of time. (9 references) (auth)

Steam and Power Conversion System

19733 (EURFNR-939) CLOSED GAS TURBINE CIRCUIT FOR A 1000 MWe GAS-COOLED FAST BREEDER. Savatteri, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1409. 95p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Progress in reactor technology allows outlet temperatures exceeding 700°C in the case of gas-cooled fast breeders. These temperatures meet the requirements of a gas turbine. To obtain directions about the final rating of a 1,000 MW(e) plant with a helium turbine, which is coupled in a direct circuit with a helium-cooled fast breeder reactor, the influence of the following parameters on process efficiency is investigated: turbine inlet temperature, compressor inlet temperature, minimum temperature difference of the heat exchanger, primary pressure, pressure loss and number of intermediate coolings. Arguments are discussed relative to the design to be selected for the turboset and the heat exchanging equipment. The pressure loss occurring in the piping system is determined and a fully integrated arrangement of the plant components is described. 38 references. (auth)

19734 GAS-CORE REACTORS FOR MHD POWER SYSTEMS. Williams, J. R.; Shelton, S. V. (Georgia Inst. of Tech.). pp 343-9 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The MHD generator is examined as one energy conversion device that can extract energy from a working fluid at a very high temperature. Coupled with the gas-core reactor, the problem of achieving high electrical conductivities is solved by providing an extremely hot working fluid and eliminating the high-specific-impulse nuclear rocket propulsion. This combined concept, with its many advantages, is submitted to meet the growing demand for power without thermal pollution. (22 references) (STAR)

Commercial Power Reactors

19735 (FIND-50295(1-72)) FIND: ZION STATION, UNITS 1 AND 2. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 31 Jan 1972. 19p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

19736 (FIND-50387(2-72)) FIND: SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 25 Feb 1972. 8p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

19737 (TID-8200(25th Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1971. (Office of the Assistant General Manager for Reactors (AEC), Washington, D. C.). 40p. Dep. NTIS.

Information about facilities in the U.S. capable of sustaining a nuclear chain reaction is tabulated. The name of the facility is

listed with location, principal nuclear contractor, type, power, and startup date. The facilities are categorized as: civilian reactors, production reactors, military reactors, reactors for export, and critical assemblies. (D.C.C.)

19738 NUCLEAR POWER PLANT'S ROLE TO BE EXPECTED IN THE FOLLOWING 15 TO 20 YEARS OF WORLD'S ENERGY ECONOMY. Selley, Gabor. Energ. Atomtech.; 23: No. 10, 477-80(Oct 1970). (In Hungarian).

The rate of development of nuclear power plants is analyzed. Future possibilities on a world scale are described. (auth)

Control and Instrumentation

19739 (DOCKET-50016-147) ENRICO FERMI ATOMIC POWER PLANT. Technical Specifications, Request for Approval of Change. (Power Reactor Development Co., Detroit, Mich.). 17 Feb 1972. 2p. Dep. NTIS.

A change in the Technical Specifications for the EFFBR is requested to specify a seven day interval for testing the sodium flow through the syphon breaker lines. (H.D.R.)

19740 (DOCKET-50255-70) PALISADES PLANT. Control Rod Drive Mechanism No. 17 Blocked by Boron Deposit. (Consumers Power Co., Jackson, Mich.). 14 Feb 1972. 3p. Dep. NTIS.

19741 (DOCKET-50255-71) PALISADES PLANT. Cooling Water in Containment Air Handling and Cooling Unit Froze. (Consumers Power Co., Jackson, Mich.). 15 Feb 1972. 3p. Dep. NTIS.

19742 (DOCKET-50271-72) VERMONT YANKEE NUCLEAR POWER STATION. Control of Combustible Gases. (Vermont Yankee Nuclear Power Corp., Rutland). 15 Feb 1972. 13p. Dep. NTIS.

19743 (DOCKET-50289-51) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Correspondence with Division of Compliance on Curing of Concrete. (Division of Compliance (AEC), Newark, N. J. Region I). 5 Jan 1972. 8p. Dep. NTIS.

Operation and Economics

19744 (DLCS-5000371) SHIPPINGPORT ATOMIC POWER STATION. Quarterly Operating Report, Third Quarter 1971. (Duquesne Light Co., Shippingport, Pa.). Contract AT-11-1-292. 21p. Dep. NTIS.

19745 (DOCKET-50003-98) INDIAN POINT STATION, UNIT 1. Failure of Worn Drive Shaft Bearings on Motor Operated Valves. (Consolidated Edison Co. of New York, Inc., New York). 22 Feb 1972. 3p. Dep. NTIS.

19746 (DOCKET-50010-104) DRESDEN NUCLEAR POWER STATION, UNIT 1. Annual Report of Station Operation for the Year 1971. (Commonwealth Edison Co., Chicago, Ill.). 14 Feb 1972. 40p. Dep. NTIS.

19747 (DOCKET-50016-148) ENRICO FERMI ATOMIC POWER PLANT. Plans to Repair Sodium Leakage. (Power Reactor Development Co., Detroit, Mich.). 16 Feb 1972. 2p. Dep. NTIS.

19748 (DOCKET-50029-168) YANKEE NUCLEAR POWER STATION. Operation Report No. 133, January 1972. (Yankee Atomic Electric Co., Westboro, Mass.). 22 Feb 1972. 9p. Dep. NTIS.

19749 (DOCKET-50133-78) HUMBOLDT BAY POWER PLANT, UNIT 3. Engine Generator Malfunction on Test. (Division of Compliance (AEC), Berkeley, Calif. Region V). 24 Feb 1972. 4p. Dep. NTIS.

19750 (DOCKET-50213-134) HADDAM NECK PLANT. Operation Report No. 72-1. (Connecticut Yankee Atomic Power Co., Haddam). 24 Feb 1972. 16p. (NYO-3144-68). Dep. NTIS.

Operations and maintenance requirements during January 1972 are described. (D.C.C.)

19751 (DOCKET-50213-135) HADDAM NECK PLANT. Environmental Radiation Survey Program, Semiannual Report, July 1, 1971-December 31, 1971. (Connecticut Yankee Atomic Power Co., Hartford). 22 Feb 1972. 31p. Dep. NTIS.

19752 (DOCKET-50219-167) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Coincident Out of Service, No. 2 Generator and No. 1 Containment Spray System. (Jersey Central Power and Light Co., Morristown, N. J.). 22 Feb 1972. 2p. Dep. NTIS.

19753 (DOCKET-50219-168) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Loss of 125V DC Bus A, January 22, 1972. (Jersey Central Power and Light Co., Morristown, N. J.). 22 Feb 1972. 2p. Dep. NTIS.

19754 (DOCKET-50219-170) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Semiannual Report No. 5, July 1, 1971-December 31, 1971. (Jersey Central Power and Light Co., Morristown, N. J.). 28 Feb 1972. 69p. Dep. NTIS.

19755 (DOCKET-50220-83) NINE MILE POINT NUCLEAR STATION. Semiannual Report of Operation, July 1, 1971-December 31, 1971. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 25 Feb 1972. 42p. Dep. NTIS.

19756 (DOCKET-50244-90) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Semiannual Report No. 4, June 26, 1971-December 25, 1971. (Rochester Gas and Electric Corp., N. Y.). 25 Feb 1972. 32p. Dep. NTIS.

19757 (DOCKET-50245-115) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Semi-Annual Operation Report, July 1, 1971-December 31, 1971. (Millstone Point Co., Hartford, Conn.). 16 Feb 1972. 81p. Dep. NTIS.

19758 (DOCKET-50245-117) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Environmental Radiation Survey Program Semiannual Report, July 1, 1971-December 31, 1971. (Millstone Point Co., Hartford, Conn.). 22 Feb 1972. 46p. Dep. NTIS.

19759 (DOCKET-50247-63) INDIAN POINT NUCLEAR GENERATING, UNIT 2. Technical Specifications, Change No. 1. (Atomic Energy Commission, Washington, D. C.). 10 Feb 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning the testing of valves for the emergency core cooling system. (D.C.C.)

19760 (DOCKET-50250-68) TURKEY POINT PLANT, UNITS 3 and 4. Response Concerning Power Assension Testing Program. (Florida Power and Light Co.). 15 Feb 1972. 3p. (DOCKET-50251-58). Dep. NTIS.

19761 (DOCKET-50254-66) QUAD-CITIES STATION, UNIT 1. Abnormal Occurrence 1-72-2. (Commonwealth Edison Co., Chicago, Ill.). 9 Feb 1972. 2p. Dep. NTIS.

Maintenance required to relocate a control rod withdrawal permission switch with respect to the refueling bridge is described. (D.C.C.)

19762 (DOCKET-50266-62) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Operation Report No. 3, July 1, 1971-December 31, 1971. (Wisconsin Electric Power Co., Milwaukee). 25 Jan 1972. 44p. (DOCKET-50301-52). Dep. NTIS.

19763 (DOCKET-50271-73) VERMONT YANKEE NUCLEAR POWER STATION. Integrated Primary Containment Leakage Rate Test. (Vermont Yankee Nuclear Power Corp., Rutland). 15 Feb 1972. 69p. (YAEC-1055). Dep. NTIS.

19764 (DOCKET-50293-64) PILGRIM NUCLEAR POWER STATION. Correspondence Relative to Missing Records. (Division of Compliance (AEC), Newark, N. J. Region I). 7 Jan 1972. 6p. Dep. NTIS.

19765 (DOCKET-50301-50) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Technical Specifications, Documentation Substantiating Review of Procedure. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 4 Feb 1972. 4p. Dep. NTIS.

Technical specifications are described which pertain to the post-core loading-precritical tests and review procedures. (D.C.C.)

19766 (DOCKET-50368-24) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Amendment No. 18. (Arkansas Power and Light Co., Little Rock). 10 Feb 1972. 51p. Dep. NTIS.

Financial data on the owners of the Arkansas Nuclear One Power Reactor Unit 2 are presented. The 1970 Annual Report of the Middle South Utilities Incorporation is included. (D.C.C.)

19767 (NP-19186) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 77, February-June 1970. (Consumers Power Co., Jackson, Mich.). 45p.

19768 (NP-19204) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 83, October-December 1971. (Consumers Power Co., Jackson, Mich.). 23p.

19769 (NP-19205) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 78, July-September 1970. (Consumers Power Co., Jackson, Mich.). 30p.

19770 (TID-25900) SENA ARDENNES NUCLEAR POWER PLANT. Report for October 1971. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 14p. Dep. NTIS.

Operations and maintenance requirements for the SENA Power Reactor during October 1971 are described. (D.C.C.)

19771 FIVE YEARS SINCE START OF THE RHEINSBERG NUCLEAR POWER PLANT: RESULTS, PROBLEMS, MEANING. Fischer, R.; Hentschel, G.; Menzel, S. (VEB Kernkraftwerke, Greifswald, Ger. Lehr- und Versuchskraftwerk, Rheinsberg, Ger.). Kernenergie; 14: No. 7-8, 221-7(Jul-Aug 1971).

Safety and Siting

19772 (DOCKET-1155-162) LA CROSSE BOILING WATER REACTOR. Emergency Core Cooling Systems, Additional Justifications for Proposed Technical Specification Change. (Dairyland Power Cooperative, La Crosse, Wis.). 10 Feb 1972. 6p. Dep. NTIS.

Additional data are presented as justification for a proposed technical specifications change for reducing the allowable primary system leakage rates in the LACBWR. (H.D.R.)

19773 (DOCKET-50029-166) YANKEE NUCLEAR POWER STATION. Technical Specifications, Proposed Change No. 96, Supplement No. 1. (Yankee Atomic Electric Co., Westboro, Mass.). 4 Feb 1972. 20p. Dep. NTIS.

Additions are presented to a proposed change in the Technical Specifications for the Yankee Power Reactor. The additions concern Zircaloy clad fuel design and manufacture, coolant pump emergency power supplies, and a steam line rupture incident. (H.D.R.)

19774 (DOCKET-50029-167) YANKEE NUCLEAR POWER STATION. Inservice Inspection Program Following Each Refueling. (Yankee Atomic Electric Co., Westboro, Mass.). 10 Feb 1972. 1p. Dep. NTIS.

19775 (DOCKET-50231-109) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Proposed Change No. 9. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 11 Feb 1972. 40p. Dep. NTIS.

Specifications are proposed to establish the conditions under which the entire SEFOR core loading of irradiated fuel rods can be stored in the irradiated fuel storage tank without adding sodium for cooling. (H.D.R.)

19776 (DOCKET-50237-216) DRESDEN NUCLEAR POWER STATION, UNIT 2. Technical Specifications, Proposed Change No. 18. (Commonwealth Edison Co., Chicago, Ill.). 9 Feb 1972. 20p. Dep. NTIS.

Changes are proposed to the Technical Specifications concerning draining of the reactor torus, maintenance of more than one control rod drive, and collection and analysis of environmental samples. (H.D.R.)

19777 (DOCKET-50237-217) DRESDEN NUCLEAR POWER STATION, UNIT 2. Special Report No. 6, Reactor Asymmetrical Neutron Flux Distribution, Supplementary Information. (Commonwealth Edison Co., Chicago, Ill.). 17 Feb 1972. 7p. Dep. NTIS.

The effects of the feedwater sparger configuration on the asymmetrical neutron flux distribution are analyzed. (D.C.C.)

19778 (DOCKET-50244-89) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Accumulation of In-Plant Exposure Through December 1970. (Rochester Gas and Electric Corp., N. Y.). 16 Feb 1972. 1p. Dep. NTIS.

19779 (DOCKET-50247-62) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Applicant's Environmental Report, Supplement No. 3. (Consolidated Edison Co. of New York, Inc., New York). 15 Feb 1972. 179p. Dep. NTIS.

A benefit-cost analysis of the Indian Point Power Reactor, Unit 2 is presented. Included are estimates of the environmental effects of the facility and the alternatives for reducing or avoiding adverse environmental effects. The environmental, economic, technical, and other benefits of the facility are described. (H.D.R.)

19780 (DOCKET-50249-117) DRESDEN NUCLEAR POWER STATION, UNIT 3. Technical Specifications, Proposed Change No. 9. (Commonwealth Edison Co., Chicago, Ill.). 9 Feb 1972. 20p. Dep. NTIS.

Changes are proposed to the Technical Specifications concerning draining of the reactor torus, maintenance of more than one control rod drive, and collection and analysis of environmental samples. (H.D.R.)

19781 (DOCKET-50249-118) DRESDEN NUCLEAR POWER STATION, UNIT 3. Special Report No. 14, Supplement. (Commonwealth Edison Co., Chicago, Ill.). 22 Feb 1972. 11p. Dep. NTIS.

Information is presented concerning a conceptual hydrogen control system for the containment system following a coolant loss accident. (D.C.C.)

19782 (DOCKET-50250-66) TURKEY POINT STATION UNIT 3. Incident Report, Safety Valve Headers. (Florida Power and Light Co.). 15 Feb 1972. 82p. Dep. NTIS.

On December 2, 1971, while the hot functional testing of Turkey Point Unit No. 3 was nearing completion, a failure occurred on a section of the safety valve header on the main steam line from the A steam generator. No fuel was in the reactor and there was no effect on the health and safety of the public. The failure was investigated and it was determined that the header piping was adequate as a pressure vessel, including the system temperature, but the external force (i.e., the reaction force from a safety relief valve operating) would stress the pipe material beyond its capacity. It was determined that the balance of the plant is unaffected by the incident; and that safety systems, instruments, controls, and plant operators can function to control such incidents so that the effects are significantly lower than those assumed for purposes of plant design and the safety analyses presented in the Final Safety Analysis Report. The subject safety headers on all three loops were redesigned taking full account of the external loads imposed by the safety relief valves. The history of the incident, the investigation, and the resulting plant design review of the Turkey Point Units are described. (auth)

19783 (DOCKET-50250-67) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Emergency Plans. (Florida Power and Light Co.). 15 Feb 1972. 437p. (DOCKET-50251-57). Dep. NTIS.

Revised and additional data are presented on the design and operation of Turkey Point Plant, Units 3 and 4. An extensive set of Emergency Plans is provided to assure protection of the public health and safety, to prevent property damage, and to limit consequences in the event of an emergency condition or radiological incident. (H.D.R.)

19784 (DOCKET-50255-69) PALISADES PLANT. Failure of Isolation Valve to Open and Misalignment of Control Rod Drive Mechanism. (Consumers Power Co., Jackson, Mich.). 11 Feb 1972. 4p. Dep. NTIS.

19785 (DOCKET-50259-37) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report,

Amendment 19. (Tennessee Valley Authority, Chattanooga). 10 Feb 1972. 151p. (DOCKET-50260–36; DOCKET-50296–34). Dep. NTIS.

Miscellaneous corrections to the Final Safety Analysis Report are presented, including an updated population distribution for the Browns Ferry site. Information on the probable maximum flood for the site and supporting hydrological engineering analyses are presented in response to requests for the data. (H.D.R.)

19786 (DOCKET-50259–38) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 21. (Tennessee Valley Authority, Chattanooga). 24 Feb 1972. 70p. (DOCKET-50260–37; DOCKET-50296–35). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactors. (D.C.C.)

19787 (DOCKET-50263–107) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. GE Report NEDO-13234 Steam Line Flow Limiting Venturi Test Program. (Northern States Power Co., Minneapolis, Minn.). 2 Feb 1972. 46p. Dep. NTIS.

Tests were carried out in air at ambient pressures and temperatures to determine the cause of the low indicated inlet-to-throat pressure differential observed in steam line flow limiting venturis having a throat piezometer ring and to determine a method of eliminating the problem. The cause of the problem was shown to be leakage into the throat pressure sensing piezometer ring from high pressure regions surrounding this ring. The solution is to bypass the piezometer ring with a single pressure tap. A repair procedure based on this solution was tested and the sensitivity of the repair to various parameters was determined. All flow Reynolds numbers of the main flow were high enough so that good modeling of plant operation is obtained. (auth)

19788 (DOCKET-50263–108) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Supplementary Report on Damage to Torus Baffles. (Northern States Power Co., Minneapolis, Minn.). 15 Feb 1972. 5p. Dep. NTIS.

19789 (DOCKET-50263–109) MONTICELLO NUCLEAR GENERATING PLANT. Instrumentation Problems, Additional Information. (Northern States Power Co., Minneapolis, Minn.). 21 Feb 1972. 4p. Dep. NTIS.

Problems with switches in the main steam line high flow isolation system and emergency core cooling system are described. (D.C.C.)

19790 (DOCKET-50266–61) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. No Leakage of Borated Water Has Been Experienced. (Wisconsin Electric Power Co., Milwaukee). 11 Feb 1972. 2p. (DOCKET-50301–51). Dep. NTIS.

19791 (DOCKET-50282–50) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 15. (Northern States Power Co., Minneapolis, Minn.). 11 Feb 1972. 183p. (DOCKET-50306–48). Dep. NTIS.

Revised design parameters of the Prairie Island Power Station, Units 1 and 2 are presented. Additional data requested by the Division of Reactor Licensing are included. (H.D.R.)

19792 (DOCKET-50289–50) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment No. 24. (Metropolitan Edison Co., Reading, Pa.). 14 Feb 1972. 140p. Dep. NTIS.

A report on the diffusion of sulfur hexafluoride tracer gas over flat terrain and in the turbulent wake of large structures near the Three Mile Island plant site during low wind speed inversion conditions is presented. The tracer experiments confirmed the validity of mathematical models used for plume dispersion. (H.D.R.)

19793 (DOCKET-50293–65) PILGRIM NUCLEAR POWER STATION. Statement on Environmental Considerations Related to the Issuance of an Operating License. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). Feb 1972. 96p. Dep. NTIS.

The environmental effects of the Pilgrim Power Reactor are examined. Included are descriptions of the site and the plant and estimates of the environmental impact of normal operation and postulated accidents. A cost-benefits analysis describes the alternatives for reducing or avoiding adverse environmental effects and presents the environmental, economic, technical, and other benefits of the facility. (H.D.R.)

19794 (DOCKET-50295–41) ZION STATION, UNITS 1 AND 2. Comments With Regard to Inspection of November 16–18, 1971. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 8 Feb 1972. 4p. (DOCKET-50304–41). Dep. NTIS.

19795 (DOCKET-50295–42) ZION STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 19. (Commonwealth Edison Co., Chicago, Ill.). 25 Feb 1972. 116p. (DOCKET-50304–42). Dep. NTIS.

Revised design parameters of the Zion Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

19796 (DOCKET-50302–36) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Antitrust Review Conducted by Department of Justice. (Florida Power Corp., St. Petersburg). 6 Dec 1971. 9p. Dep. NTIS.

19797 (DOCKET-50309–54) MAINE YANKEE ATOMIC POWER STATION. Environmental Effects of Thermal Discharge. (Maine Yankee Atomic Power Co., Westboro, Mass.). 24 Feb 1972. 3p. Dep. NTIS.

19798 (DOCKET-50309–55) MAINE YANKEE ATOMIC POWER STATION. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Feb 1972. 104p. Dep. NTIS.

19799 (DOCKET-50312–34) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Steps Taken to Correct Items in Letter Dated January 14, 1972. (Division of Compliance (AEC), Berkeley, Calif. Region V). 16 Feb 1972. 4p. Dep. NTIS.

Corrective actions are described for testing battery chargers for the 125 volt d.c. system, inspection of construction, and quality control program on field erected tanks. (D.C.C.)

19800 (DOCKET-50321–31) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment No. 12. (Georgia Power Co., Atlanta). 14 Feb 1972. 118p. Dep. NTIS.

Revised and additional data are presented concerning hydrological characteristics of the site and stress limits and design parameters for the containment structure. Additional data on the reactor requested by the Division of Reactor Licensing are also included. (D.C.C.)

19801 (DOCKET-50358–32) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 22 Feb 1972. 200p. Dep. NTIS.

19802 (DOCKET-50363–20) FORKED RIVER NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment No. 12. (Jersey Central Power and Light Co., Morristown, N. J.). 18 Feb 1972. 209p. Dep. NTIS.

Revised design parameters of the Forked River Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

19803 (DOCKET-50367–27) BAILLY GENERATING STATION, NUCLEAR I. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 16 Feb 1972. 187p. Dep. NTIS.

A technical safety review and evaluation of the Bailly Power Reactor, Unit 1 is presented. The evaluation is based on the Preliminary Safety Analysis Report for the facility and includes design aspects of the systems and components, calculated potential consequences of routine and accidental release of radioactive materials, the scope of development programs, and the technical competence of the owner and contractors. It is concluded that the facility can be constructed and operated without undue risk to the health and safety of the public. (H.D.R.)

19804 (DOCKET-50373–14) LA SALLE COUNTY STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 7. (Commonwealth Edison Co., Chicago, Ill.). 22 Feb 1972. 95p. (DOCKET-50374–14). Dep. NTIS.

Revised and additional data are presented concerning the containment structure, site excavations, and hydrological and seismological data for the site. (D.C.C.)

19805 (DOCKET-50373-15) LA SALLE COUNTY STATION, UNITS 1 AND 2. Application for Construction Permits, Amendment No. 8. (Commonwealth Edison Co., Chicago, Ill.). 22 Feb 1972. 92p. (DOCKET-50374-15). Dep. NTIS.

Financial data on the owners of the LaSalle County Power Reactor Units 1 and 2 are presented. The 1971 Annual Report of the Commonwealth Edison Company is also included. (D.C.C.)

19806 (DOCKET-50373-16) LA SALLE COUNTY STATION, UNITS 1 AND 2. Environmental Report, Supplement No. 3. (Commonwealth Edison Co., Chicago, Ill.). 28 Feb 1972. 28p. (DOCKET-50374-16). Dep. NTIS.

Requested additional information is presented concerning possible radioactive discharges from the reactors. (D.C.C.)

19807 (DOCKET-50376-29) AGUIRRE NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment No. 15. (Puerto Rico Water Resources Authority, San Juan). 25 Feb 1972. 79p. Dep. NTIS.

Financial data on the owners of the Aguirre Power Reactor Unit 1 are presented. The 1970-1971 Annual Report and the October 1971 Monthly Report of the Puerto Rico Water Resources Authority are included. (D.C.C.)

19808 (DOCKET-50382-17) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment No. 11. (Louisiana Power and Light Co., New Orleans). 24 Feb 1972. 27p. Dep. NTIS.

Additional data concerning soil properties and excavations for the reactor site are presented. (D.C.C.)

19809 (DOCKET-50400-9) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment No. 1. (Carolina Power and Light Co., Raleigh, N. C.). 9 Feb 1972. 161p. (DOCKET-50401-9; DOCKET-50402-9; DOCKET-50403-9). Dep. NTIS.

Requested additional data concerning design parameters and operations aspects of the reactors are presented. (D.C.C.)

19810 (DOCKET-50400-10) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Supplement to Letter Dated January 12, 1972. (Carolina Power and Light Co., Raleigh, N. C.). 15 Feb 1972. 16p. (DOCKET-50401-10; DOCKET-50402-10; DOCKET-50403-10). Dep. NTIS.

Supplementary information is presented concerning the request for issuance of construction permits for all four units of the Shearon Harris Nuclear Power Plant in a single review proceeding. (H.D.R.)

19811 RADIATION PROTECTION AS A PART OF ENVIRONMENTAL PROTECTION IN GENERATION OF ELECTRIC POWER FROM NUCLEAR ENERGY IN THE GERMAN DEMOCRATIC REPUBLIC. Albrecht, L.; Roehnsch, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie; 14: No. 7-8, 227-31(Jul-Aug 1971).

The radiation protection standards in the Democratic Republic of Germany are described. The release limits for radioactive discharges from nuclear power plants are discussed. 19 references. (D.C.C.)

19812 PRESENT STATE OF THE INSURANCE AGAINST NUCLEAR RISKS IN THE COMMUNITY. Rabe, Dietrich (Kommission der Europaeische Gemeinschafte, Brussel). At. Strom; 17: No. 10, 164-6(Oct 1971). (In German).

The development of an international legal liability for damages arising with the operation of nuclear power plants as well as with the transport of fissile material is set forth. The Commission of Euratom contributed to the subject by publishing relevant skeleton policy projects. The ratification of the effective dates for the international liability agreements is reported. A comparison between the rather "regional" Convention of Paris and the "worldwide" Convention of Vienna reveals differences as to the legal liability. In the Community too, "nuclear pools" are representing the majority of the underwriters covering civil nuclear risks. (auth)

Propulsion and Auxiliary Power Reactors

Refer also to abstracts 17766 and 19737.

19813 (NAA-SR-Memo-5315) THE SNAP 10 CRITICAL ASSEMBLIES. Podeweltz, C. M. (Atomics International, Canoga Park, Calif.). 24 May 1960. Contract AT(11-1)-Gen-8. 28p. Dep. NTIS.

The SNAP 10 assemblies are cylindrical in shape, with alternating plates of fuel (U-ZrH, $\frac{3}{4}$" thick) and conductor materials (Be, 0" to 20" thick) comprising the core, and radial and axial reflectors made of 2-$\frac{1}{2}$" thick Be. The end reflectors are variable in thickness. The approach to critical is made axially by stacking up fuel and conduction plates until a K_{eff} value very near 1 is reached. The final adjustment is made by varying the thickness of end reflector. Critical dimensions of four assemblies were calculated, primarily with the aid of the AIM-3 multigroup diffusion code. The S_N transport code and previous critical assembly data were also used for supplementary calculations. (auth)

19814 (NAA-SR-Memo-5495) DEVELOPMENT PLAN FOR MULTI-PURPOSE COMPACT NUCLEAR POWER SYSTEMS (SNAP 4). (Atomics International, Canoga Park, Calif.). 18 Nov 1960. Contract AT(11-1)-Gen-8. 58p. Dep. NTIS.

The development program for the SNAP 4 Compact Power System is presented. The plan leads to the development of two power plant concepts that use an identical reactor but differ only in the power conversion systems. The first power plant, called the SNAP 4A system, is a 2 MW(e) packaged transportable nuclear power system which utilizes conventional power conversion equipment. It is packaged in three operational modules and can be flown in four C-130 type aircraft. The second power plant, called the SNAP 4B system, is a versatile, highly compact, single module system. Even though designed specifically for underwater application, it is suitable for surface or terrestrial operation with additional shielding and, where cooling water is not available, an atmospheric cooler. This plant uses special power conversion equipment which must be developed. (auth)

19815 (PWAC-81) DATA ON TWO LIQUID METAL TURBOJET POWERPLANTS UTILIZING THE CIRCULATING FUEL REACTOR WITH A FLUORIDE FUEL TEMPERATURE OF 1700F. Tiedemann, Harold J. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 3 Dec 1953. Contract AT(30-1)-2789. 13p. (FXM-594). Dep. NTIS.

The performance for various flight conditions is compared for two 300 MW circulating fuel aircraft reactors coupled to liquid metal heated turbojet engines. (H.D.R.)

19816 (PWAC-85) OFF-MATCH POINT PERFORMANCE OF THE LIQUID METAL TURBOJET WITH A CIRCULATING FUEL REACTOR. Tiedemann, Harold J. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 31 Dec 1953. Contract AT(30-1)-2789. 85p. (FXM-610). Dep. NTIS.

A series of aircraft powerplants using liquid metal turbojets with circulating fuel reactors was investigated for off-match point performance, weight, and geometry. The results of the powerplant comparisons for various flight conditions are presented. (H.D.R.)

19817 (PWAC-97-B) NORMALIZED PERFORMANCE PARAMETERS FOR A CHEMICAL-NUCLEAR TURBOJET OF 7/1 COMPRESSOR PRESSURE RATIO USING 1500F FLUORIDE FUEL. Tiedemann, H. J. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 7 Sep 1954. 31p. Dep. NTIS.

Performance parameters normalized at an altitude of 35,000 feet for various degrees of afterburning are presented to aid in determining flight performance at altitudes above 35,000 feet. (auth)

19818 (PWAC-97(Suppl. A)) ESTIMATED PERFORMANCE DATA FOR A CHEMICAL-NUCLEAR TURBOJET OF 7/1 COMPRESSOR PRESSURE RATIO USING 1500°F FLUORIDE FUEL AND AN AFTERBURNING TEMPERATURE OF 3200°F. Tiedemann, H. J. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 30 Jun 1954. 22p. Dep. NTIS.

Estimated performance data are presented for the ten engine configurations of PWAC-97 at an afterburning temperature of 3200°F. (auth)

19819 (PWAC–141) ESTIMATED PERFORMANCE AND WEIGHT OF A TWIN POWER PACKAGE USING TWO 120 MW SOLID FUEL ELEMENT REACTORS. Andrews, N. D. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 9 Nov 1955. 13p. Dep. NTIS.

Estimated performance and weight are presented for two power-package powerplants arranged to power one airplane. Each power package contains one 120 MW solid fuel element reactor. Each reactor is closely coupled to two nuclear-chemical turbojet engines each of which has a sea level static airflow of 400 lbs/sec and a design compressor pressure ratio of 7/1. The two engines, reactor and associated pumps and equipment are completely contained in a streamlined pod. The results presented include net thrust, thrust specific fuel consumption, reactor power, airflow and a breakdown of the powerplant weight. (auth)

19820 (PWAC–142) ESTIMATED WEIGHT SCALING DATA FOR A TWIN POWER PACKAGE USING THE SOLID FUEL ELEMENT REACTOR. deGanahl II, C. F.; Andrews, N. D. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 15 Dec 1955. 6p. Dep. NTIS.

Estimated data are presented for scaling the component weights of the power package powerplant consisting of a solid fuel element reactor closely coupled to one, two, or three nuclear-chemical turbojet engines each of which has a sea level static airflow of 400 lbs/sec and a design compressor pressure ratio of 7/1. The data presented are in the form of curves which enable scaling the weight of the NaK system components and the turbojet engine from a reactor power of 40 MW to 100 MW per engine and the weight of the reactor, shielding and intermediate heat exchanger system from a total reactor power of 40 MW to 300 MW. (auth)

19821 (PWAC–144(Sec.2)) POWERPLANT CHARACTERISTICS SUMMARY. SECTION II. (Pratt and Whitney Aircraft, East Hartford, Conn.). 2 Feb 1956. 94p. Dep. NTIS.

Performance data are presented for the NJ-2B aircraft powerplant. The powerplant consists of a sodium cooled reactor and turbojet engines operable on both nuclear and chemical energy. (H.D.R.)

19822 (PWAC–175) NJ-6A, NJ-8A ENGINE PERFORMANCE SUMMARY. (Pratt and Whitney Aircraft, East Hartford, Conn.). 1 Apr 1957. 132p. Dep. NTIS.

The weights, design characteristics, and performance of the NJ-6A and NJ-8A nuclear turbojet engines are presented. These engines are assumed to be nuclear conversions of the Pratt & Whitney Aircraft J-91 engine. The NJ-6A was designed to meet the requirements for high altitude supersonic flight. The NJ-8A was designed to meet the requirements of low altitude, subsonic flight. Both engines can be operated on nuclear heat alone, nuclear heat plus conventional fuel, or conventional fuel alone. (auth)

19823 (PWAC–260) NUCLEAR POWERPLANT FOR NAVY PREPROTOTYPE AIRPLANE. Meyer, Robert M. (ed.) (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 1 Oct 1958. 33p. Dep. NTIS.

A nuclear powerplant design for the Princess airframe which meets the Navy requirements for a preprototype airplane is selected. The conclusions on which the selection of the nuclear powerplant design was based are presented, and a résumé is given of the status of reactor technology and the research and development work which supports this selection. (auth)

19824 (PWAC–262) NUCLEAR POD-MOUNTED TURBOJET POWERPLANT CHARACTERISTICS SUMMARY. Bronke, V.; Gaffin, W. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 21 Nov 1958. Contract AT(11-1)-229. 14p. Dep. NTIS.

Information is presented on a power plant intended for application to subsonic airplanes, such as logistics carriers, personnel carriers, airborne alert missile launchers, and AEW airplanes, which require a large portion of the fuselage volume to be shielded to relatively low radiation levels. The power plant consists of two wing-mounted pods, each containing two nuclear turbojet engines and one lithium-cooled, solid fuel element reactor. (auth)

19825 (PWAC–263) PRELIMINARY INSTALLATION AND PERFORMANCE OF THE NT-15 POWERPLANT. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 15 Dec 1958. 55p. Dep. NTIS.

A preliminary description and estimated performance of a nuclear turboprop power plant suitable for application to the Princess flying boat are presented. This power plant, consisting of a nuclear reactor heat source with unit shielding, two modified T-57 turboprop engines and associated heat exchange equipment, is estimated to provide sufficient power to fly the Princess airplane, at maximum gross weight with adequate climb margin, at 220 knots and 10,000 feet altitude on nuclear power alone. Based on the preliminary engineering studies made to date, the power plant described is believed to be the most practical design for the Princess airplane application. (auth)

19826 (TID–5079) AIRCRAFT POWER PLANT ANALYSIS. Report No. 163-R2. Bond, F. Jr.; Mould, R.; Preston, A. (Flader (Fredric) Inc., North Tonawanda, N. Y.). 20 Oct 1950. 64p. Dep. NTIS.

The power plant includes two separate and distinct cycles which are nevertheless closely interdependent in operation. The first of these is a closed vapor cycle whose useful output is shaft power from a steam turbine and whose heat sink is an air-cooled condenser. The second is an open, air cycle in the form of a jet engine. The reactor cooling system utilizes water as a coolant and the vapor cycle to drive the air compressor. The condensers contribute a major part as the heat sink function in the vapor cycle, and supply heat to the air in the jet engine cycle. The maximum coolant temperature was limited to 980°F and the pressure was established at 5,000 psi. The coolant is plain water deaerated and distilled to remove impurities. The coolant circulates directly through the reactor core and functions as the primary moderator. Control is effected by varying flow through the reactor. (auth)

19827 (TID–15062) RADIATION EFFECTS ON A NUCLEAR ROCKET ENGINE SYSTEM. Final Report. (Rocketdyne, Canoga Park, Calif.). 14 Jul 1961. Contract AT(29-2)-771. 266p. (R–3007). Dep. NTIS.

The problems of radiation environment in a nuclear rocket engine system are analyzed for the K-1 preliminary engine design, and an optimum system configuration is obtained which incorporates radiation-resistant components and structure throughout. Pertinent test programs are recommended for inclusion in the Kiwi-B reactor experiments at the Nevada Test Site. (auth)

19828 COMPARISON OF CLOSED- AND OPEN-CYCLE SYSTEMS. Schwenk, F. C.; Franklin, C. E. (U. S. Atomic Energy Commission). pp 3-11 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP–236.

The nuclear light bulb and the coaxial flow, gaseous core reactors are described. Calculated critical masses for both the open cycle and the closed cycle systems are evaluated, emphasizing neutronic requirements and characteristics. The transparent wall in the nuclear light bulb and fluid mechanics in both systems are also examined. To heat hydrogen and to attenuate radiant energy in the gas core propellant, the fuel was seeded with either a gas having a low ionization potential or with submicron-sized particles of a highly absorbing material. (10 references) (STAR)

19829 RELATIONSHIP BETWEEN ENGINE PARAMETERS AND THE FUEL MASS CONTAINED IN AN OPEN-CYCLE GAS-CORE REACTOR. Ragsdale, Robert G. (NASA Lewis Research Center). pp 13-22 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP–236.

The major features of an open-cycle gaseous-fueled nuclear rocket engine are that it provides high specific impulse and high thrust but loses some uranium fuel during operation. An analysis is carried out to relate the amount of uranium that would be contained in such an engine to engine performance parameters. The parameters considered are: cavity diameter, reactor pressure, engine thrust, specific impulse, and the hydrogen-to-uranium flow rate ratio. Several auxiliary equations are developed as a part of the analysis. Recent mechanics experimental data are used to show that the fraction of the reactor cavity filled with uranium is inversely proportional to the approximate cube root of the hydrogen-to-fuel flow rate ratio. Equations are also developed that give the uranium density and opacity as a function of reactor pressure and fuel temperature. These equations are

incorporated into a simplified radiant heat transfer equation. (9 references) (auth)

19830 SUMMARY OF RESEARCH ON THE NUCLEAR LIGHT BULB REACTOR. Clark, James W.; McLafferty, George H. (United Aircraft Research Labs.). pp 23-7 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The overall nuclear light bulb research program is outlined along with the progress to date. A thermal environment was simulated for ratio frequency experiments. Results of radiant energy source tests, transparent wall model tests, and propellant heating experiments are summarized. Engine dynamics and startup analyses using a UNIVAC 1108 digital computer are briefly discussed, as well as radiation heat transfer and optical absorption in fused silica. (STAR)

19831 COLLOID-CORE CONCEPT: A POSSIBLE FORERUNNER FOR THE GASEOUS CORE. Tang, Y. S.; Stefanko, J. S.; Dickson, P. W. (Westinghouse Electric Corp.). pp 29-36 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

A concept using a colloid-fuel, vortex chamber cavity is described. Theoretical analysis of the system characteristics and a conceptual design of a ground test reactor are included. The reactor uses particulate fuel with a composition (1U−10Zr)C. The uranium is ^{233}U, and the fuel is fed to the cavity by hydrogen gas. The cavity, a compressed vortex chamber, has an L/D ratio of 0.15 in the fuel-bearing zone. Beryllium is used as the reflector material. The reflector, as well as the other core components, is cooled by hydrogen passages and is contained in a titanium alloy (T−Al−V) pressure vessel. The engine would generate a 100,000-lb thrust with a specific impulse of 1200 lb-sec/lbm. (auth) (STAR)

19832 PULSED PLASMA-CORE ROCKET REACTORS. Winterberg, F. (Univ. of Nevada). pp 37-45 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

It is shown that the two principal problems of gas-core reactors, i.e., fuel-propellant separation and material problems resulting from the high operating temperatures, can be greatly reduced in a pulsed operation to very high temperatures by a fast-growing chain reaction. An expression for the reactor economy is derived which shows that with increasing maximum temperature in the pulsed reactor operation, the same fuel burnup is possible with a smaller fuel propellant separation. In the limiting case of temperatures above 10 to the 7th power K, represented by the bomb propulsion concept, no separation is needed. The other limiting case, that of complete separation realized in the solid-core rocket reactor, can also be recovered from the general formula. (auth) (STAR)

19833 GASEOUS FISSION CLOSED-LOOP MHD GENERATOR. Sherman, Arthur (Computer and Applied Sciences, Inc.). pp 47-51 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The question of achieving a very low specific weight for a nuclear electric space power plant in order that an electrical propulsion system could prove very attractive for space flight is considered. The study of a gaseous fission reactor operating at moderate temperatures in a closed-loop power plant with an MHD generator as the energy converter is suggested. (auth) (STAR)

19834 EXPERIMENTS ON THE CONTAINMENT OF SIMULATED FUEL IN UNHEATED AND HEATED VORTEXES. Mensing, Arthur E.; Jaminet, Jerome F. (United Aircraft Research Labs.). pp 65-9 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Experiments were conducted to investigate the simulated-fuel containment characteristics of vortex flows similar to those which would be employed in a nuclear light bulb engine. Isothermal tests using a 10-in.-diam vortex chamber showed that volume-averaged simulated-fuel partial pressures in excess of those required for the nuclear light bulb engine are feasible. Similar tests using a 1.26-in.-diam vortex chamber in which a temperature gradient of approximately 50,000°K/in. was impressed on the vortex flow showed that the temperature gradient resulted in a substantial reduction in the diffusion of the simulated fuel to the peripheral wall of the vortex chamber. The results of experiments with both heated and unheated vortex flows are summarized. (auth) (STAR)

19835 EXPLORATORY PLASMADYNAMIC STUDIES OF VORTEX AND COAXIAL FLOW GEOMETRIES EMPLOYING RADIO-FREQUENCY INDUCTION HEATING. Keyes, J. J. Jr.; Sartory, W. K. (Oak Ridge National Lab.). pp 71-82 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Experiments are described in which the effect of high energy density, volumetric heating on jet-driven vortex flow of argon and on coaxial flow of helium and argon were determined. The plasmas were heated inductively at atmospheric pressure to peak temperatures estimated to be between 10,000° and 15,000°K. Experiments with vortex tubes revealed that significant increase in the ratio of tangential velocity to injection velocity is effected when the argon gas is heated to plasma conditions. A superconducting magnet capable of generating reasonably uniform axial magnetic flux densities of up to 2.3 W/sq m is described. Initial coaxial-flow studies using a 2-in.-dia quartz outer tube for helium and a 1¼-in.-dia graphite injection tube for argon resulted in a positive correlation of magnetic flux density and coupling between the radiofrequency field and the positive correlation of magnetic flux density and coupling between the radiofrequency field and the plasma. It is suggested that the magnetic field increases the effective argon concentration in the plasma. (auth) (STAR)

19836 EXPERIMENTAL STUDY OF THE EFFECT OF INLET CONDITIONS ON THE FLOW AND CONTAINMENT CHARACTERISTICS OF COAXIAL FLOWS. Johnson, Bruce V. (United Aircraft Research Labs.). pp 83-93 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Exploratory experiments for studying coaxial flow characteristics for gas core nuclear rockets are described. The path of the simulated propellant is approximately in the direction of the axis of symmetry and the flow cross sectional area is approximately constant for a significant distance from the inlet. The large eddy disturbances which occurred in previous coaxial flow jet tests with discontinuous inlet velocity profiles were essentially eliminated by the use of a porous material upstream of the inlet plane to smooth out the inlet velocity profiles. Use of these materials also decreased the rms axial velocity fluctuation from 40% to approximately 7% in the test chamber near the inlet plane. The apparent inner jet gas containment obtained with the modified porous-material inlets was considerably improved. With Freon 11 as the inner jet gas, the containment at a ratio of outer stream flow rate to inner jet flow rate of 25 was twice that for previous tests. (auth) (STAR)

19837 SELF-CONFINED ROTATING FLOWS FOR CONTAINMENT. Moore, F. K.; Leibovich, S. (Cornell Univ.). pp 95-103 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Examples of fluid flows with regions of closed streamlines away from solid boundaries are described with gaseous nuclear fuel containment in mind. Confining mechanisms are rotation (either swirl or smoke ring) or electromagnetic pinch. Experimental experience and a recent theory of vortex breakdown confirm the existence of such flows. Further, it is shown that with

suitable choices of parameters, theory predicts constant pressure (stagnation) in the confined regions, which is probably favorable in both stability and mixing-loss terms. Effects of density difference and energy evolution and transfer are discussed. (auth) (STAR)

19838 STABILITY OF TWO-FLUID WHEEL FLOWS WITH AN IMPOSED UNIFORM AXIAL MAGNETIC FIELD. Monnin, Carl F.; Reinmann, John J. (NASA Lewis Research Center). pp 105-27 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The stability of an incompressible two-fluid wheel flow to infinitesimal helical disturbances is studied. The inner fluid is heavy and has infinite electrical conductivity, whereas the outer fluid is light and is nonconducting. An axial magnetic field is externally imposed on both fluids. This configuration may be viewed as a Rayleigh–Taylor problem in the frame of the rotating fluid and is dynamically unstable. Growth rates increase with increasing axial wavelength and azimuthal mode numbers but decrease with increasing axial magnetic field. By increasing the magnetic field sufficiently, the system can be made stable to short axial wavelength disturbances for any azimuthal mode. (auth) (STAR)

19839 STABILITY CONSIDERATIONS FOR A TRANSPARENT WALL IN A GASEOUS NUCLEAR ROCKET. Tam, C. K. W.; Goracke, D. B.; Lewellen, W. S. (Massachusetts Inst. of Tech.). pp 129-33 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The stability of infinitesimal disturbances on an inviscid, incompressible model of coaxial flow around a cylinder of stationary fluid of differing density separated by a thin, flexible wall is studied. The pinch mode of disturbance is found to be the most unstable. The wall strength required to insure that no disturbance will grow along the boundary is determined as a function of density ratio and the dynamic pressure of the flow. A numerical example indicates that adequate strength can be obtained within the thickness limit imposed by the heat absorption constraint existing in the nuclear light bulb concept of a gaseous nuclear rocket, but the margin is close enough to suggest that other possible additive effects merit further analysis. (auth) (STAR)

19840 ACOUSTIC INSTABILITY DRIVEN BY ABSORPTION OF RADIATION IN GASES. Monsler, Michael J. (AVCO-Everett Research Lab.); Kerrebrock, Jack L. pp 135-7 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971). (CSR-T-69-4).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Previous work on fluctuations in a radiating gas is extended to include an opacity which is a function of temperature and pressure and most importantly, to include a net radiative heat flux and gradients in the thermodynamic variables. These extensions allow the investigation of an instability driven by the absorption of radiation by waves in the gas. The effect of this will be to limit the maximum possible net radiative heat flux in a problem to a value which can be substantially lower than that predicted by the usual steady state heat transfer analysis. (auth) (STAR)

19841 STATUS OF OPACITY CALCULATIONS FOR APPLICATION TO URANIUM-FUELED GAS-CORE REACTORS. Patch, R. W. (NASA Lewis Research Center). pp 165-71 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The principal mode of heat transfer in gas-core nuclear reactors and rockets is thermal radiation. In order to assess the feasibility of such reactor and rocket concepts, the opacities of the substances in the reactor chamber must be known from calculations or experiments. The status and results of such calculations for hydrogen, seeds, and uranium are given and the status of experiments is discussed. It is concluded that present opacity calculations are probably accurate enough to assess the feasibility of a uranium-fueled gas-core reactor or rocket, but the confidence level is not yet satisfactory. (33 references) (auth) (STAR)

19842 NEUTRON KINETICS OF CAVITY REACTORS. Podney, Walter N. (Inst. for Defense Analyses); Smith, Harold P. Jr.; Oppenheim, A. K. pp 219-30 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

A theory is presented that describes power level variations in a cavity reactor produced by density changes in a gaseous nuclear fuel within the cavity. Effects of a density change are accounted for in terms of a cavity grayness, which is the ratio of the net thermal neutron current to thermal neutron flux at the cavity wall. The percent change in power level per neutron generation is shown to be proportional to reactivity plus a term proportional to rate of change of grayness. The rate dependent term is unique to cavity reactors and is expected to have a pronounced effect on reactor stability. Implications for stability of cavity reactors to motion of fuel within the cavity are considered. For a large cavity radius, defined in terms of a minimum critical radius, power level is sensitive to motion of fuel toward or away from the cavity wall. Expansion of a central fuel region within the cavity increases reactivity, and, conversely, contraction decreases reactivity. Power excursions with period of the order of 100 sec can result if natural damping forces provided by pressure and temperature gradients within the cavity are not strong enough or quick enough to arrest an initial expansion or contraction. (12 references) (auth) (STAR)

19843 COUPLED FLUID AND NEUTRONIC OSCILLATIONS IN HIGH-TEMPERATURE GASEOUS URANIUM. McNeill, Harry; Becker, Martin (Rensselaer Polytechnic Inst.). pp 231-5 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The similarity of the core of the gaseous core nuclear rocket to the combustion chamber of a chemical rocket suggests that acoustic instabilities which were troublesome in chemical rocket systems may also occur in the gaseous core nuclear rocket system. The analysis of a simplified and idealized physical model with the radiant heat transfer characteristics of a high temperature uranium plasma shows that two distinct wave phenomena can occur. One wave, called a heat wave, is stable, but the other wave, which is an acoustic wave, can become unstable. Neutronic damping due to gas dynamic field and neutron field interaction results in a significant influence toward stability of the acoustic oscillation. The results of investigations show that, even with the stabilizing effect of radiant heat transfer and neutronic damping, instabilities can occur within the size envelope of current gas core rocket conceptual designs. (auth) (STAR)

19844 RADIANT HEAT FLUX LIMIT OF BYPASS FLOW IN A URANIUM PLASMA ROCKET. Kascak, Albert F. (NASA Lewis Research Center). pp 237-41 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

A two dimensional radiative-convective analysis was used to calculate the temperature distribution in the annular propellant region. A diffusion approximation was used in this part of the analysis. A transport analysis was then used to calculate the wall heat flux from the propellant temperature distribution. The maximum wall heat flux increased from near zero to about 0.5 kW/sq in. when 80 percent of the total hydrogen flow was bypassed. In the wall heat flux calculation, the hydrogen in the cavity was assumed to contain 0.7 weight percent solid seed material with an absorption cross section of 50,000 sq cm/g (5000 sq m/kg). These are values that were experimentally achieved. The 0.7 weight percent of seed material in the cavity would amount to about 1 percent of the total hydrogen flow. This amount of seed would have a negligible effect on specific impulse. The overall conclusion is that a large fraction of the hydrogen propellant can bypass the engine cavity without causing an excessive radiant heat flux on the cavity wall. (auth) (STAR)

19845 STUDY OF THERMAL RADIATION ABSORPTION PROCESSES IN GAS-CORE REACTORS. Partain, W. L.; Williams, J. R.; Clement, J. D. (Georgia Inst. of Tech.). pp 243-58 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Data on the thermal emission spectrum from uranium plasma indicate that the radiant energy entering the propellant region of a gas core reactor would lie in the wavelength range between 1200 and 7000 Å. Since hydrogen at temperatures below about 8000°K is transparent to this radiation, it must be seeded to make it absorb this radiant energy and become heated. Submicron-sized refractory metal particles appear to be the best seed material for this application because they are highly absorbing throughout this wavelength range and can withstand high temperatures without vaporizing. Calculations using the Mie theory show that submicron-sized particles of carbon, tungsten, and silicon are highly absorbing, whereas submicron-sized particles of nonconducting materials, such as aluminum oxide, are almost purely scattering and would therefore not be useful as a seed material. The carbon-hydrogen aerosol exhibited a slight increase in extinction parameter as the temperature was raised to 2170°K. The carbon particles react with hydrogen to produce methane at temperatures above 1000°K; however, small concentrations of methane greatly retard the reaction rate. Similar measurements of the extinction parameter of tungsten-hydrogen aerosols at 12.5-atm pressure showed a significant increase in the extinction parameter with temperature from about 18,000 sq cm/g at 730°K to about 50,000 sq cm/g at 1770°K. Measurements of the scattering of a 6328-Å laser beam from submicron-sized carbon, tungsten, silicon, tungsten carbide, and silicon carbide particles dispersed in nitrogen gas demonstrate the highly forward nature of the scattering. Electron micrographs illustrate the sizes and shapes of the particles used for these investigations. (27 references) (auth) (STAR)

19846 RADIATION TRANSPORT IN A URANIUM PLASMA REACTOR WITH REFLECTING WALLS. Keim, S.; Peschka, W. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Stuttgart). pp 259-65 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

The temperature distribution and the radiation flux are determined for the plasma region of a plasma reactor which is appropriate for MPD energy conversion. The pressure of the uranium plasma will be of the order of 50 atm. Therefore, the diameter of the fuel plasma zone should attain 1 m because the reactor must become critical. The plasma reactor investigated uses liquid lithium flowing along the inner walls of the reactor in the axial or azimuthal direction. Results from the calculations show that the total radiation flux near the walls is reduced considerably despite the very high temperatures at the middle of the reactor, and the radiation flux is reduced by the reflecting walls. (10 references) (auth) (STAR)

19847 APPLICATION OF ZONING TECHNIQUES IN PRACTICAL RADIATIVE ENERGY TRANSPORT PROBLEMS. Keng, Edward Y. H. (Georgia Inst. of Tech.). pp 273-81 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Methods which use zoning techniques to extend the existing results of a simple radiative energy transport model and thereby permit solutions to be obtained for many complex systems are discussed. View factors for black body and gray body systems and view factors among zones are presented. Nonisothermal emission conditions and approximation techniques for systems with variable extinction coefficients are outlined. (STAR)

19848 INVESTIGATION OF NUCLEAR LIGHT BULB START-UP AND ENGINE DYNAMICS. Latham, Thomas S.; Bauer, Harold E.; Rodgers, Richard J. (United Aircraft Research Labs.). pp 285-90 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Analytical studies were conducted to determine the operating conditions of a nuclear light bulb engine during startup and the transient response of the engine to various perturbations at the nominal full-power operating level. The dynamic characteristics of the uncontrolled nuclear light bulb engine at full-power operating conditions are described. The variations of critical mass and fuel and moderator average temperatures during engine startup are also discussed. (auth) (STAR)

19849 CALCULATIONS OF THE SPECTRAL EMISSION FROM THE FUEL REGION OF A NUCLEAR LIGHT BULB REACTOR. Krascella, Nicholas L. (United Aircraft Research Labs.). pp 291-9 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

A program was formulated to determine the effects of (1) changes in the heavy-atom model parameters, (2) addition of a seed gas, and (3) inclusion of reflective end walls on the spectral radiation emitted from the fuel region of a nuclear light bulb engine. The iterative procedure, unit cavity configuration and conditions, and a description of the cases used in the program are summarized as well as calculated temperature distributions near the fuel edge. It was found that the radiative flux spectral distribution differs appreciably from that of a blackbody at a temperature of 15,000° R; and that the addition of a seed gas such as hydrogen tends to attenuate the radiation emitted in the ultraviolet region of the spectrum. The use of end walls with reflective coatings such as aluminum tends to shift the spectral distribution of radiated energy to higher wave numbers for a given total flux emitted from the fuel. (12 references) (STAR)

19850 DEVELOPMENT OF A HIGH-INTENSITY RF RADIANT ENERGY SOURCE FOR SIMULATING THE THERMAL ENVIRONMENT OF THE NUCLEAR LIGHT BULB REACTOR. Roman, Ward C. (United Aircraft Research Labs.). pp 301-6 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

A radiant energy source design is reviewed for use in simulating a vortex-stabilized nuclear light bulb engine. The source geometry and flow pattern of the high-power, high-pressure RF plasma are outlined. The 1.2 MW RF induction heater power source, resonator section, and fiber optic scanning system for determining the discharge diameter, shape, and stability are described. The effects of varying discharge power on the discharge geometry; the radial distribution of temperature variations of discharge power density and radiant energy flux with discharge power; and chamber pressure effects on the fraction of power radiated are shown graphically. (STAR)

19851 EXPERIMENTS FOR SIMULATING THE ABSORPTION OF THERMAL RADIATION IN THE PROPELLANT DUCT OF A NUCLEAR LIGHT BULB REACTOR. Klein, John F. (United Aircraft Research Labs.). pp 307-12 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Experiments to simulate the absorption of thermal radiation in the propellant duct of a nuclear light bulb reactor are described. The experimental objectives include (1) development of methods for injecting solid particle seeds into a simulated propellant stream, (2) the effective usage of buffer layers to prevent coating of the duct walls, and (3) the absorption of a large percentage of incident radiation from a high-intensity light source in a simulated propellant stream. A discussion of the results obtained in initial experiments is presented. (10 references) (auth) (STAR)

19852 COMMENTS ON THE COLLOID-CORE REACTOR. Jackomis, W.; von Ohain, H. (Aerospace Research Labs.). pp 415-17 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

A review of the Colloid Core Nuclear Reactor Rocket Engine concept is given, including principal operating features, performance goals and comparisons with other nuclear engine concepts. A brief summary of major research efforts in multicomponent flow is presented, along with areas in which further investigation is needed to complete a feasibility study of the colloid core reactor design. (13 references) (auth) (STAR)

Control and Instrumentation

19853 (PWAC-270) CONTROL SYSTEM ANALYSIS OF THE NT-15 NUCLEAR TURBOPROP POWERPLANT. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 1 Feb 1959. 81p. Dep. NTIS.

The results are presented of digital and analog computer studies of the control system of the NT-15 nuclear turboprop power plant proposed for installation in the Princess flying boat. The propulsion system proposed for the installation includes the nuclear power plant and four chemically fueled Pratt & Whitney Aircraft T-34 turboprop engines. The nuclear power plant comprises a PWAR-13 reactor, the liquid metal system necessary to transport heat energy from the reactor to the engines and two Pratt & Whitney Aircraft T-57 turboprop engines. The T-57 engines may be operated individually and independently on nuclear heat, chemical fuel or a combination of the two. The Princess installation has the capability of cruising on nuclear heat only. Takeoff and landing are accomplished on chemical fuel with both T-57 and T-34 engines operating. (auth)

19854 (TID-6248) IRRADIATION TESTING OF XMA-1A SHIELD MATERIALS. Bauer, P.; Welch, F. H.; Kilb, E. P. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). 7 May 1959. 34p. (DC-59-5-81). Dep. NTIS.

The results of the irradiation tests on (a) Beryllium-boron, (b) Borided tungsten alloy, (c) Lithium hydride, (d) Boron stainless steel, and (e) Beryllium oxide-boron are discussed. Data from the tests are included. The tests were conducted to simulate 100 hour operation of the XMA-1A power plant at the design temperatures and nuclear fluxes. (auth)

19855 (TID-6461) REPORT ON REACTOR SIDE SHIELD COOLING SYSTEM DESIGN. Brooks, Robert O. (Kinetics Corp., Cincinnati, Ohio). 30 Apr 1960. Contract AT(11-1)-171. 156p. (XDC-60-8-104). Dep. NTIS.

For General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.

Heat transfer studies were performed to determine cooling tube size, location, etc. to insure adequate cooling of the P-140 and P-142 side shields by the use of ram cooling air. Also included in the report are some time-saving suggestions and methods for calculating cooling air flow rate and salt internal temperature drops. (auth)

19856 (TID-14875) XMA-1A FRONT SHIELD PLUG THERMODYNAMIC APPRAISAL. Final Report. Mills, R. R. Jr.; Heck, J. (Aircraft Armaments, Inc., Cockeysville, Md.). Nov 1959. Contract AT(11-1)-171. 443p. (ER-1832). Dep. NTIS.

For Aircraft Nuclear Propulsion Dept., General Electric Co., Cincinnati, Ohio.

The Transient Heat Transfer (THT) analyses of the thermodynamic characteristics of the XMA-1A Front Shield Plug configuration investigated in detail various geometrical regions of the configuration during steady state operation of the plug and during the scram or shutdown cooling process. In addition, certain regions were investigated, in a preliminary manner, for the slow start-power transfer process. Moreover, various regions of the configuration were subjected to parametric variations in, for example, the magnitude of the secondary fluid flows passing over the section or the gap characteristics of the interior contained (fill) material. The thermodynamic conclusions reached as a result of these analyses are summarized, and certain recommendations, either involving extended analyses of the configuration under certain conditions, or involving various specific considerations to be applied to the present geometrical configuration, are presented. (auth)

19857 (TID-14877) XMA-1A REAR SHIELD PLUG THERMODYNAMIC APPRAISAL. Final Report. Schwartz, D. B.; Mouring, B. W.; Ruark, D. W. (Aircraft Armaments, Inc., Cockeysville, Md.). Nov 1969. Contract AT(11-1)-171. 214p. (ER-1787). Dep. NTIS.

For Aircraft Nuclear Propulsion Dept., General Electric Co., Cincinnati, Ohio.

The results of a thermodynamic appraisal of the XMA-1A Rear Shield Plug are presented. The Transient Heat Transfer (THT) results presented were obtained by the application of Design Point 2 steady state data and estimated transient operating characteristics for scram. An uncertainty factor of 2 was applied to all nuclear heating rate predictions utilized in these analyses. A subsequent study of the results indicated that certain minor design modifications were necessary to effect a workable configuration, and consequently the changes were made. Complete temperature estimates resulting from the revised geometry are included. (auth)

Operation and Economics

19858 GAS-CORE NUCLEAR ROCKET WITH FUEL SEPARATION BY MHD-DRIVEN ROTATION. Park, Chul; Love, Wendell L. (NASA Ames Research Center). pp 139-48 of Research on Uranium Plasmas and Their Technological Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

A gas-core nuclear rocket is described in which fuel containment is achieved through the application of an MHD-centrifuge scheme. Solid-body rotation of the gas would be developed in a cylindrical cavity in order to obtain maximum separation of the fuel gas from the propellant gas. Heating of the propellant gas would be accomplished by radiative transfer from the fuel region near the wall as the propellant flows axially through the center region of the cavity. Encouraging results were obtained from a preliminary experiment to test the effectiveness of MHD-driven rotation for separating two gas species in a closed cylindrical chamber. The operating characteristics and projected performance of a gas-core nuclear rocket engine using this scheme for fuel containment were calculated and typical results are presented. (12 references) (auth) (STAR)

Safety

Refer also to abstract 17699.

19859 (R-60-FPD-555) DESIGN APPROACH FOR A NUCLEAR ROCKET ENGINE. Watts, A. A.; Brisken, R. W. (eds.) (General Electric Co., Cincinnati, Ohio. Flight Propulsion Div.). 7 Oct 1960. Contract AT(11-1)-171. 164p. Dep. NTIS.

An approach is presented for a comprehensive preliminary design study for a complete nuclear rocket engine system. The study includes mission analysis, system synthesis and analysis investigations, and extensive component design studies. Considerable attention is directed to problems associated with the nozzle, the propellant feed system, thrust vector control, and integration of the reactor into the system. The latter problems pertain to the pressure shell and support structure, shielding requirements, the coordination of propellant and reactor controls, and testing and flight hazards. An approach is presented also for establishing a complete development and testing program for a nuclear rocket engine. This approach emphasizes reliability and safety considerations, as well as application of advanced management techniques. (auth)

19860 (TID-16394) EFFECTS OF LIQUID PROPELLANT EXPLOSIONS ON NUCLEAR ROCKET ENGINES. Final Report. (Little (Arthur D.) Inc., Cambridge, Mass.). 14 Mar 1962. Contract NAS8-523. 87p. Dep. NTIS.

The final report of a program designed to determine the hazards which might result from a launching mishap of a SATURN class vehicle with a nuclear-powered upper stage is presented. The program consisted of two phases. The first was an experimental effort in which characteristics of explosions of SATURN propellants were determined. The second phase was an analytical program designed to predict the effects of a propellant explosion on a nuclear reactor of the Kiwi-B class. The analytical procedures used in this second phase and the conclusions reached are described. 26 references. (auth)

19861 RADIATION HAZARD FROM BACKFLOW OF FISSION FRAGMENTS FROM THE PLUME OF A GAS-CORE NUCLEAR ROCKET. Masser, Charles C. (NASA Lewis Research Center). pp 267-71 of Research on Uranium Plasmas and Their Technologi-

cal Applications. /Thom, Karlheinz (ed.). Washington, D. C.; National Aeronautics and Space Administration (1971).

From Symposium on research on uranium plasmas and their technological applications; Gainesville, Fla. (7 Jan 1970). See NASA-SP-236.

Analytical calculations are performed to determine the particle flux that leaves a rocket plume in a vacuum and strikes the rocket forward of the nozzle. The rocket plume is generated by the products of a gas-core nuclear reactor and consists of hydrogen, uranium, and fission fragments. The backflow flux is determined by the number of particles that leave the continuum of the plume and strike the rocket without experiencing any particle collisions. A percentage of these particles that strike the rocket are fission fragments and the radiation dose to the crew is calculated. A total of 1.68 lb of fission fragments is formed from a gas-core rocket that produces 1,000,000 lb of thrust at a specific impulse of 1500 sec for a propellant consumption of 1,000,000 lb. Of the 1.68 lb of fission fragments only 0.42×10^{-8} lb flow back from the plume and only 0.66×10^{-10} lb strike the rocket. This weight of fission fragments causes a total integrated dose of less than 0.00013 rad to the crew, which is well below acceptable levels. (auth) (STAR)

Process Heat and Desalination Reactors

Refer also to abstract 17643.

Operation and Economics

19862 INVESTIGATIONS IN THE USE OF NUCLEAR REACTORS FOR DISTRICT HEATING. Krueger, Horst; Timm, Manfred (Hamburgische Electricitaets-Werke AG, Hambrug). At. Strom; 17: No. 10, 158-63(Oct 1971). (In German).

The economic points of view in the use of nuclear energy for meeting the increasing demand for district heating are discussed and comparisons made with conventional installations fired with fossil fuels for district heating. The type of installation, its size, annual utilization period and, particularly in the case of thermal power stations, the credit to be added for the power generated, which is a linked product, are the most important parameters whose influence on the economic efficiency is investigated. When present data on capital expenditure and fuel costs are taken into account the results do not show any very clear advantage of nuclear energy installations for the generation of district heating when compared with ordinary fossil-fueled installations. (auth)

Research and Test Reactors

Refer also to abstracts 18182, 19698, and 19737.

19863 (GULF-RT-A-10898) FAST REACTOR SPECTRUM MEASUREMENTS. Quarterly Progress Report, August 1–October 30, 1971. Young, J. C.; Verbinski, V. V.; Crosbie, K. L. (Gulf Radiation Technology, San Diego, Calif.). 30 Nov 1971. Contract AT(04-3)-167. 35p. Dep. NTIS.

The work performed during the third quarter of 1971 on a continuing program of Fast Reactor Neutron Spectrum Measurements in Subcritical Assemblies (STSF) is described. All of the planned time-of-flight spectrum measurements were performed for two cores, STSF-9 and -10. Preliminary analysis of these data was made. The neutron spectrum measured in STSF-9 with in-core, proton-recoil detectors is compared with time-of-flight measurements. (13 references) (auth)

19864 (JAPFNR-19) STUDY OF THERMAL CHARACTERISTICS OF THE JOYO CORE. III. EVALUATION OF THERMAL MIXING EFFECT AND COOLANT TEMPERATURE DISTRIBUTION OF JOYO CORE. Miyamoto, Yoshiaki (Japan Atomic Energy Research Inst., Tokyo). Translation of report PNC-J-250-71-19. 68p. Dep. NTIS (U. S. Sales Only).

Hydraulic mixing effects in rod bundles and the relation between hydraulic and thermal eddy diffusivity in sodium are studied. Correlation functions of the thermal mixing effect for the JOYO are proposed. Coolant temperature distributions of the JOYO core are calculated by the use of the proposed correlation functions. 13 references. (auth)

Control and Instrumentation

Refer also to abstract 19706

19865 (IAEA-R-651) AN AUTOMATIC START-UP SYSTEM FOR RESEARCH REACTORS. Final Report for the Period 1 July 1969–30 June 1971. Hassan, M. A. (International Atomic Energy Agency, Vienna (Austria)). Jul 1971. 85p. INIS.

Theoretical study and development of a practical system for optimal policies and sub-optimal control of start-up and level changes in the research reactor WWRS (2 MW) in the Atomic Energy Establishment, Inshas, UAR, are discussed. Physical, technological and safety constraints were to be taken into consideration when formulating the optimum problems. This was done in order to limit complexity of the resulting system and to follow the optimization criterion, that is, to achieve required change in a minimum of time. A three-dimensional state estimation and control optimization problem was formulated in order to evaluate the loss in performance for the solution of more complex control problems. The maximum principle was used to develop the necessary conditions and numerical methods through successive linearization. Electronic blocks, necessary for the practical implementation of the automatic start-up and sub-optimal control were developed, using solid state and integrated circuits. In addition to that, analogue instruments for the estimation of the state parameters from noise measurements, (e.g. reactivity) and digital blocks to perform different sequencing functions, were developed for control and position measurements, also an integrated system was developed and experienced on the research reactor WWRS. The result is an original sub-optimal start-up system for research reactors which is easy to implement. Numerical algorithms and electronic blocks developed will contribute to solve other possible control problems. (INIS)

19866 (KFK-EXT-8/70-7) CALCULATION AND DESIGN OF A SODIUM-AIR-HEAT-TRANSFER SYSTEM FOR THE PLANNED FAST TEST REACTOR FR 3. Spilker, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Dec 1970. 128p. (In German). INIS.

Subsequent to an explanation of the theoretical fundamentals of the thermodynamic and hydraulic design a description is given of a parameter study for the determination of the optimum variant of the heat transfer system. The results of the study are converted into diagrams by the computer. Due to special restrictions a variant is selected and its technical data are described. The annex contains all computer programs used. (INIS)

Operation and Economics

19867 (DOCKET-50231-110) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Clarification of Proposed Change No. 9. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 18 Feb 1972. 2p. Dep. NTIS.

Additional information is presented concerning operating procedures for the spent fuel storage tank. (D.C.C.)

19868 (ORO-852-5) TEXAS A AND M UNIVERSITY NUCLEAR SCIENCE CENTER. Progress Report No. 8, January 1–December 31, 1971. Randall, John D. (Texas Engineering Experiment Station, College Station). Mar 1972. Contract AT-(29-2)-852. 73p. Dep. NTIS.

The activities of the Nuclear Science Center during 1971 are summarized. The reactor facility administration, operations, and modifications are described. (H.D.R.)

Safety and Siting

19869 (AI-68-Memo-127) FFTF SODIUM FIRES AND BLAST ANALYSIS STUDY. Hopenfeld, J.; Silberberg, M.; Johnson, R. (Atomics International, Canoga Park, Calif.). 13 Feb 1969. Contract B8L-S77-42371. 71p. Dep. NTIS.

One of the concepts under consideration for FFTF refueling involves the use of a hot cell which is located over the reactor vessel and within the outer containment. In the event of a loss of integrity of the reactor top shield plug due to the DBA, the refueling hot cell becomes a part of the inner containment barrier. It is also the inner containment barrier for accidents such as sodium-pool and spray fires which may be postulated during certain shutdown operations such as during loop maintenance. Of direct interest is the magnitude of pressure generated in the hot cell during an accident. The hot cell configurations being considered include a rectangular one and an alternate concept having a cylindrical geometry. Estimates were made of the pressures and temperatures generated for a range of accident conditions postulated for the FFTF. The hot cell atmosphere was considered to be either air or inert (2 v/o O_2). The condi-

tions that exist when the hot cell is vented to adjacent volumes are also examined. In addition, the consequences with respect to the outer containment were evaluated for the same range of accidents, in the absence of the hot cell. (auth)

19870 (HEDL-TME-71-174) USER'S GUIDE FOR THE IRRADIATION OF EXPERIMENTS IN THE FTR. Schively, D. P. (Hanford Engineering Development Lab., Richland, Wash.). Dec 1971. Contract AT(45-1)-2170. 119p. Dep. NTIS.

A second issue of the "Users' Guide for Irradiation of Experiments in the FTR" was prepared to update the original issue of September 1970 (WHAN-FR-23). General adherence to the format of the "Users' Guide for EBR-II" was continued. The section on plant handling procedures was expanded and the latest pertinent FTR neutronics have been included. Other revisions pertain to procedural clarifications and delineation of quality assurance requirements. 9 references. (auth)

19871 (KFKI-71-74) CONSTRUCTION AND DOSIMETRY OF BIOLOGICAL IRRADIATION FACILITIES AT LIGHT-WATER-MODERATED REACTORS. Makra, S.; Zarand, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 14p. Dep. NTIS (U. S. Sales Only).

Different construction possibilities for biological irradiation facilities and two versions developed in the Central Research Institute for Physics, Budapest are discussed. The reactor in question is a light water moderated and cooled thermal reactor of the WWR-S type. The first irradiation facility made use of a 100 mm dia horizontal beam tube, the dose rate was in the order of magnitude of 1 rad/s, the homogeneity of the field was not sufficient for class A irradiation. The second version has an enlarged beam diameter of 150 mm, the dose rate and the neutron/gamma ratio can be altered by changeable bismuth filters, the homogeneity of irradiation is fairly good. Measurement methods include G/M tube monitors, activation and TLD techniques, while neutron spectrum and kerma calculations are performed with a code which computes the spectrum of the core modified by different filters. Measured data are evaluated by using a fitting code. Different effects influencing dose rate stability, i.e. displacement of absorbers inside the core (control rods, cadmium-encapsulated specimen, etc.), reactor poisoning and burn-up, as well as re-fuelling are discussed. (16 references) (auth)

19872 (TID-12271(Pt.2)) FORCED CONVECTION LIQUID METAL INPILE LOOP HAZARDS EVALUATION. Vassallo, D. B. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 16 Jul 1959. 22p. (TIM-602). Dep. NTIS.

An evaluation and discussion of the potential hazard which may result from flow stoppage of the liquid metal coolant during operation of the inpile loop in the C66J-13 core facility of the Engineering Test Reactor (ETR) are presented. (19 references) (auth)

Production Reactors

Refer also to abstract 19737.

Reactor Components, Fuels, and Accessories

Refer also to abstracts 17659, 17687, 17689, 17774, 17775, 17897, 18112, 18139, and 18400.

19873 (GEAP-12246) FISSION GAS RE-SOLUTION RATES. Quarterly Report No. 5, July 1-September 30, 1971. Marlowe, M. O. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Oct 1971. Contract AT(04-3)-189. 29p. Dep. NTIS.

Progress in an experimental program to determine the resolution rates of fission gases in oxide nuclear fuels under irradiation is described. As-irradiated specimens at burnups of approximately 0.1, 1.2, and 3.2×10^{20} fissions/cm^3 were examined by transmission electron microscopy. Considerable radiation damage and some dislocations that were not present in the as-fabricated samples were observed. No fission gas bubbles were detected. Annealing of the irradiated specimens in the electron microscope at high beam currents produced fission gas bubbles. Specimens annealed at 1300°C for 16 hours exhibited detectable bubbles only on grain boundaries and at dislocations. A specimen which was heated to 1575°C after irradiation showed an essentially uniform concentration of bubbles with a log-normal size distribution; the geometric mean diameter was 72 Å and the geometric standard deviation was 1.42. (auth)

19874 (RDT-C-14-1-T(1-72)) CONTAINMENT EXHAUST RADIATION MONITORING SYSTEM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 18p. RSO.

The basic requirements for design, fabrication, cleaning, handling, testing, calibration, marking, packaging, shipping and quality assurance for a containment exhaust radiation monitoring system used in the plant protection system of a nuclear reactor facility are presented. (auth)

19875 DOORS WITH INTERLOCKING MEANS. Thorpe, James Albert (to United Kingdom Atomic Energy Authority). British Patent 1,260,852. 19 Jan 1972. Filed 29 May 1968.

Reference is made primarily to air-lock doors for nuclear reactor installations. Disadvantages associated with existing systems are stated, and the object of the system described is to provide doors having simple but efficient mechanically operated interlocking means. The system comprises pairs of doors having fastening mechanisms with cam actuated bolts that are mechanically interconnected by a flexible push-pull cable and arranged so that the bolts are mutually operable from either side of the doors and so that at any time at least one bolt is in a fastening position. Means are provided for latching the bolts against movement towards the fastening position when one door is open; this ensures that where one door is closed and fastened and the other door is open the fastened door cannot be unfastened before the other door is closed and fastenable. Each door preferably carries a pressure equalizing valve operable by the fastening mechanisms. (UK)

19876 BRAKE-SYSTEM. Jug, Victor; Tortel, Jean (to Commissariat a l'Energie Atomique). French Patent 1,459,145. 15 Feb 1971. Filed 4 Jul 1968. 1st Addition 95,560. (In French).

A braking device for a mass in motion chiefly applicable to the braking of control rods propelled at high speed into the core of a reactor is described. The device consists of a guide piston of the mass to be braked with two parts of different diameter. The first part freely slides on the piston and the second part is the braking part consisting of annular section in sliding contact with the piston at the first part. (tr-auth)

19877 NUCLEAR REACTOR UTILIZING PLUTONIUM. Crowther, R. L. (to General Electric Co.). Canadian Patent 887,349. 30 Nov 1971.

A fuel assembly for a nuclear reactor utilizes fissile isotopes of Pu within the core. The Pu fuel is graduated across the bundle to take advantage of Pu fuel characteristics. Mixing of the Pu fuel with natural or depleted U may also be utilized. (F.S.A.) (Canada)

Reactor Physics and Core Engineering

Refer also to abstract 18391.

Physics

Refer also to abstract 19698.

19878 (AE-439) ADJUSTMENT OF NEUTRON CROSS SECTION DATA BY A LEAST SQUARE FIT OF CALCULATED QUANTITIES TO EXPERIMENTAL RESULTS. PART II. NUMERICAL RESULTS. Haeggblom, H. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Nov 1971. 70p. Dep. NTIS (U. S. Sales Only).

Discrepancies between calculated and experimental integral data for fast zero-power reactors were used for obtaining adjustments of some of the underlying energy-dependent data given in the SPENG Library. The adjustments were obtained by a least-square method which gives also standard deviations of the adjusted data. The results include integral data and corresponding standard deviations obtained by using the adjusted neutron cross sections. The calculations were based upon 57 integral data from 31 different assemblies and give corrections of 31 neutron data divided into 6 energy groups. 77 references. (auth)

19879 (DUN-4829) HAMMER: A HANFORD VERSION. Agee, L. J. (Douglas United Nuclear, Inc., Richland, Wash.). Oct 1968. 122p. Dep. NTIS.

The Hanford HAMMER Program for reactor physics calculations is in general an expanded version of the original HAMMER system, and considerable effort was made to preserve all the major features of it. Thus most of the original input instruction and output description is still applicable to the Hanford version. The modified and expanded portions of the program are described. Included are revised input instructions, output description, and a "Hanford Use and Limitation Section". Also included are pseudo-flow charts of the main control program (CAPN), the HAMLET link, and the new PAGE/HEAD section. (auth)

19880 (LFEN-NI.-67-b) METHOD TO ISOLATE THE FUNDAMENTAL DECAY MODE OF THERMAL NEUTRON FLUX IN A MODERATOR. Martinho, E. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1971. 15p. Dep. NTIS (U. S. Sales Only).

A method to isolate the fundamental decay mode of thermal neutron flux in a moderator is presented. The diffusion of neutrons from a plane and uniform source in a moderator with parallel-epipedic geometry and a square base with finite dimensions is considered. The method is applied to the measurement of the diffusion length of thermal neutrons in water. (auth)

19881 APPLICATION OF MODAL ANALYSIS TO THE APPROXIMATE SOLUTION OF THE FERMI-AGE EQUATION. Al-Ammar, M. A. (Nuclear Research Centre, Baghdad); Obradovic, D.; Tudhope, R. G. J. Brit. Nucl. Energy Soc.; 11: No. 1, 43-8(Jan 1972).

A brief discussion of the relative merits of the various mathematical models used to describe the space-time behavior of the neutron flux in a reactor core is given. Modal analysis, in the form of spatial eigenfunction expansions, is chosen as a suitable model and is applied to the approximate solution of the neutron diffusion equation in the Fermi-age or continuous slowing down approximation. An expression for the space dependent transfer function of a multi-region reactor core is obtained. A critical condition, in the form of an algebraic eigenvalue problem, is also developed from the stationary equations. Computer programs based on these expressions were developed and numerical results for the space dependent transfer function were obtained. These are compared with previously published experimental work and results of a two-group analysis on the Norwegian reactor NORA. (auth) (UK)

19882 SOME CALCULATIONS OF THE CORRELATION MEASURED IN THE ROSSI-α EXPERIMENT. Reiche, Chr. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 7-8, 248-52(Jul-Aug 1971).

An analytical solution of the Rossi-α correlation is given for the one-dimensional bare problem. This solution is compared with results of the reflected system obtained by numerical calculations. The extension of the methods used before to two-dimensional problems is considered. 9 references. (auth)

GENERAL

Law

Refer also to abstract 17853.

19883 TRAINING REQUIREMENTS FOR RADIOPHARMACISTS IN RELATION TO RADIOPHARMACEUTICALS OF GENERATOR-PRODUCED RADIOISOTOPES. Tubis, M. (Veterans Administration Center, Los Angeles. Univ. of California, Los Angeles). pp 3-10 of Radiopharmaceuticals from Generator-Produced Radionuclides. Vienna; International Atomic Energy Agency (1971).

From Preparation and control of radiopharmaceuticals conference; Vienna, Austria (11 May 1970). See STI/PUB-294; CONF-700517.

The training requirements for radiopharmacists dealing with radiopharmaceuticals prepared from generator-produced radioisotopes cannot be differentiated from the requirements for all radiopharmacists. The growing need for radiopharmacists is generated by three main factors: (1) the expanding use of short-lived radionuclides requiring at-the-site-preparation of radiopharmaceuticals; (2) the demand for special radiopharmaceuticals not regularly available from commercial suppliers; and (3) the growing demand from governmental regulatory agencies for competent personnel to handle these drugs. To meet this demand the School of Pharmacy of the University of Southern California has instituted a program in radiopharmacy to train radiopharmacists. The pharmacist will have adequate training in the bacteriological, biological, chemical, pharmaceutical, pharmacological, and clinical sciences, as well as in the specialized knowledge of pertinent radiological sciences. The specialized program comprises a full calendar year divided into three parts. The first semester deals with the basic radiation sciences, the second semester comprises radiopharmacy, nuclear medicine, research seminars and ancillary activities, and the third semester consists of a full-time internship in a center of nuclear medicine, in actual practice of the profession. Detailed information of the contents of the courses are presented and discussed. (auth)

Miscellaneous

19884 (AEEW-M-822) COMPUTER PROGRAMME FOR THE DYNAMIC ANALYSIS OF EXPERIMENTS (DYNALEX). Hobbs, B. M. (Atomic Energy Establishment, Winfrith (England)). Jun 1968. 13p. Dep. NTIS (U. S. Sales Only).

19885 (BNWL-SA-4123(Rev.)) REGULATION OF EXOCELLULAR ENZYME SYNTHESIS. Drucker, Harvey (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. Contract AT(45-1)-1830. 13p. Dep. NTIS.

19886 (BNWL-SA-4210) TRYPTOPHAN REPRESSION OF EXOCELLULAR PROTEASE IN NEUROSPORA. Drucker, H. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. Contract AT(45-1)-1830. 6p. Dep. NTIS.

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19889 (CONF-710501-47) EFFECT OF SEASON ON THYROID RELEASE OF ^{131}I IN FREE-RANGING EASTERN CHIPMUNKS (TAMIAS STRIATUS). Kodrich, W. R. (Clarion State Coll., Pa.); Tryon, C. A. (Pittsburgh Univ., Pa. Pymatuning Lab. of Ecology). [1970]. Contract AT(11-1)-3426. 11p. Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

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From third thermal expansion symposium; Corning, N. Y. (27 Oct 1971).

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The 2θ values are tabulated and arranged in order of increasing wave length and in tables with increasing atomic number. (J.S.R.)

19899 (KFK-EXT-2/71-1) REPORT ON PEACEFUL RESEARCH. Lecture Series. Liedke, Gerhard (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct 1971. 397p. (In German). Dep. NTIS (U. S. Sales Only).

Peace is, since the invention and employment of nuclear weapons, the condition essential for the life of the scientific-technical generation. Peace can however only be established when it is defined not only as the absence of war but also as a positive continuous action. This action is characterized as a minimization of force, a minimization of misery, and a minimization of suppression at all levels—from the international level to the inner psychic level of a single man. Contributions of many sciences are to be united for a total perspective of the peace actions: contributions of social sciences, of political sciences, of the sciences of history, of jurisprudence, of military strategy research, of revolution research, of economics, of technology, of biology, of psychology, of education, of philosophy, and perhaps also of theology. The—until now not satisfactory—attempts to investigate the conditions of peace are in these lecture series presented and discussed. (auth)

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